



## AVOCADO PRODUCTION AND THE SECTORAL INNOVATION SYSTEM<sup>1</sup>

*María de la Luz Martín Carbajal<sup>2</sup>*  
*Salvador Padilla Hernández<sup>3</sup>*

### Introduction

The avocado sector in Mexico has been the subject of a great quantity of studies that define its national and international importance, based in frameworks such as the chain of value, the cluster and the Porter diamond (Sánchez, 2006; CICTAMEX, Faculty of Agro-biology of the Universidad Michoacana de San Nicolás de Hidalgo (UMSNH), to name a few). These analyses have demonstrated the productive composition of the sector in describing the links in the chain of value according to production or commercialization criteria or by defining foreign competition, principally in the United States, in accord with variables such as quality, price, training, channels of distribution and technology, with the last in terms of utilization of resources, assessment, investment, competitors, and exportation.<sup>4</sup> Even so, the study of the avocado sector based on these points of view does not permit inferences to be made over the innovative relations that have been established by the agents which surround this agricultural property.

Our general intention here is to describe, on one hand, the elements of the sectoral innovation system (SIS) for avocado production, when and how they emerge, and what type of innovative relationship have been established between them. On the other hand, it is to study how the internal mechanisms that stimulate the SIS function, in other words, the learning of technology and the institutions involved.

The relationships between the different actors of the SIS are influenced by contextual factors. This is especially important for the institutions that adopt the international public norms of the *Food Industry Code* which insures that agricultural products are wholesome, along with the rules that regulate the entrance of agricultural products into different countries, such as the *Governing Plan for the Avocado Sector* which establishes some of the actions in place to strengthen proper practices in production, harvest and packaging of avocados. There are also at least five national norms that assure quality of avocados<sup>5</sup>, along with contracts for exclusivity and the rules for the functioning of associations integrated with the SIS.

---

<sup>1</sup> Translated by Dr. Kimberly Anne Brooks-Lewis.

<sup>2</sup> Faculty of Economics. Universidad Michoacana de San Nicolás de Hidalgo. Email: mmartincarbajal@gmail.com

<sup>3</sup> Faculty of Economics. Universidad Michoacana de San Nicolás de Hidalgo. Email: spadilla@zeus.umich.mx, spadilla47@yahoo.com.mx

<sup>4</sup> Although there is also the technical perspective of the tariff barriers there have been numerous studies undertaken by different institutions such as the Faculty of Agro-biology of UMSNH, INIFAP, the PRODUCE Foundation, CICTAMEX and OCDE and from the point of view of the models for the analysis of economic politics associated with the regulations and technical barriers in agricultural markets (Orden et al., 1999; Roberts and Orden, 1996)

<sup>5</sup> Norms such as NMX-FF-016-SCFI-2006 that establish the specifications for quality the avocado must be met, with the Hass variety, because it is eaten fresh after its selection and packing. NOM-066-FITO-2002 and NOM-128-SCFI-1998 specify the rules for plant health and transportation of avocados and for its tagging, respectively. Along with these

In the realization of this study we employed documental sources along with interviews with different actors in the SIS. Given that in this research we include multiple agents of the avocado SIS, we divided the system into three principal subsystems: producers, packers and processors. We also selected local agents such as associations<sup>6</sup>, a research institute (INIFAP), the faculty of a university (Faculty of Agricultural Biology, UMSNH), financial institutions<sup>7</sup>, promotional institutions<sup>8</sup>, and the PRODUCE Foundation of Michoacan, who are agents connected with the creation and diffusion of knowledge and development of technological capabilities in the three subsystems mentioned.

In the case of the subsystem of processors, we involved in the conversations with experts, business owners, directors and general and plant managers located in Uruapan, Michoacan, asking the same interview questions. These businesses present various attributes; they are the principal Mexican producers of avocado oil, guacamole and cosmetics; they represent 25% of the exterior sales of avocado products on a national level and 36.5% in Michoacan; they are firms with different grades of technological maturity; and they present different grades of integration and diversification. Finally, the market of the producers studied is principally foreign, given that in Mexico the consumer culture of processed products is incipient.

This work is organized in four sections. In the first the commercial performance of the Michoacan avocado sector is described; in the second we briefly present the composition of the avocado SIS; in the third we analyze the elements of the system; and in the fourth we present the principal results of the research.

### **1. Commercial performance in the Michoacan avocado sector**

The Michoacan avocado sector has had good commercial performance from the beginning of the 60s. According to FAO estimations, in the period 1961-2006, on a worldwide level there were 77,550 million tons (mtn) generated, of which 76% were produced in America (59,570 mtn); 10.8% in Africa (9,364 mtn); 12.3% in Asia (7,672 mtn); 2.9% in Europe (1,495.5 mtn); and 0.8% in Oceania (647.4 mtn).

The principal exporting countries for the period 1990-2005, as shown in chart 1, five nations have incremented their exportation, Mexico, Chile, Israel, Spain and South Africa. While the exportations of Mexico during 1990-1995 were 13% of the worldwide total, in the following periods they rose by 8 and 14%. Foreign sales for Israel, Spain and South Africa diminished 5.2%, 16% and 7% respectively during the period of 1990-1995.

---

norms, there are guidelines such as those in *Good Agricultural Practices and Good Management Practices* for the process of production and packing that establish the rules that producers and packers must follow to reduce biological, chemical and physical risks that put the wholesomeness of the product, and therefore the health of the consumers. Also, the *Food Industry Manual and Transport of Fresh Fruit and Vegetables in Innocuous Materials*.

<sup>6</sup> Association of Avocado Producers and Packers of Michoacán (APEAM), State Committee of Vegetal Health (CESV), State Committee of Avocado Production Systems (CESIPRO), Michoacán Avocado Commission A.C. (COMA), Association of Exporters and Packers of Mexican Avocados (ASEEM), Local Association of Avocado Producers of Uruapan, Michoacan (APROAM), Association of Producers and Packers of Michoacan (ASEAM), Local Board of Vegetal Health (JLSV), National Council of Avocado Producers A. C. (CONAPA), and the Union of Avocado Packers and Marketers of Michoacan (UDECAM).

<sup>7</sup> National Finance Company (NAFIN), National Bank of Exterior Trade (BANCOMEXT), Secretary of Agriculture, Ranching, Rural Development, Livestock and Food Industry (SAGARPA), Secretary of Agriculture and Livestock Sector (SEDAGRO), Secretary of Economic Development (SEDECO), Secretary of Social Development (SEDESOL), Secretary of Planning and Development (SEPLADE), Secretary of Natural Resources (SEMARNAT), Rural Finance Company (FR), Trusts Established in Relation with Agriculture (FIRA), Aid Program for Facilitating Access to Rural Financing (PAFAF), Aid Program for Agreements for Rural Financing Services (PAASFIR), and the Trust for Shared Risk (FIRCO).

<sup>8</sup> System of Information and Statistics of the Food and Agricultural Industry (SIAP) and the National System of Information and Integration of Markets (SNIM).

Chart 1				
Avocado: main exporter countries by period, 1990 – 2005				
Country \ Period	1990 - 1995	1996 - 2000	2001 - 2005	1990 - 2005
From 100 to 1000 ton	86.5	89.5	88.7	88.46
Mexico	13.1	21.5	27.6	22.58
Chile	7.6	12.2	20.5	15.19
Israel	21.3	14.2	8.4	12.96
Spain	14.1	14.7	8.9	11.77
South Africa	16.2	10.0	8.6	10.7
France	4.6	5.0	3.8	4.31
Holland	2.9	5.1	4.4	4.26
Kenya	4.1	4.0	3.7	3.87
Dominican Republic	2.7	2.8	2.9	2.82
From 10 to 99 ton*	10.9	9.1	9.9	9.92
Less than 10 tons**	2.6	1.4	1.4	1.63
Total	100	100	100	100
* United States, New Zealand, Guatemala, Venezuela, Peru, Ecuador, Germany, Belgium, United Kingdom, Brazil, Italy.				
** Rest of the world.				
Source: Personal elaboration based on FAOSTAT data.				

For the period of 2002-2006<sup>9</sup> the market quota for avocado in Michoacan, the markets of the United States and Canada represent 48% and 89%, respectively, of the worldwide importation of avocado (Figures 1 and 2). On the other hand, of the avocado consumed by Japan, 97% comes from Michoacan and three percent from Chile, the United States and New Zealand, while in Europe Mexico participated with only 14%, competing with Israel, South Africa, Kenya and Peru (Figures 3 and 4). As can be seen, the competitive position of Michoacan in the international market is particularly strong in the United States, Canada and Japan, while in Europe there is a lesser participation in comparison to the principal competitors – Israel, Kenya, South Africa and Peru.

The factors that are active behind the commercial performance of the avocado sector in Michoacan must be understood. To begin such an explanation, in the following we present a general description of the general composition of the avocado SIS in Michoacan.

<sup>9</sup> To obtain the participation or market quota of a product from each country in each of the nations or worldwide regions we divided the value of the exports of the country “i” by the total of the imports of the country “j”.

Figure 1  
Michoacán's participation on the market of the  
avocado of the United States, 2002 - 2006

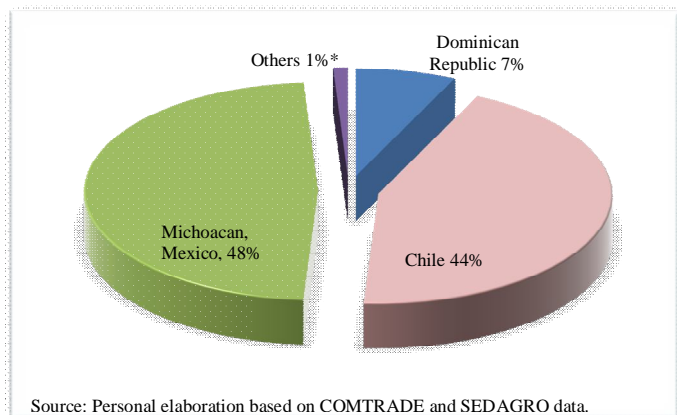


Figure 2  
Michoacán's participation on the market of the avocado of Canada, 2002 - 2006

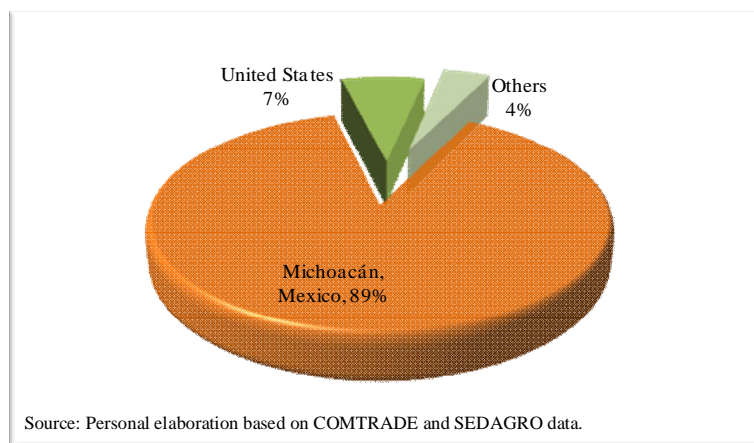


Figure 3  
Michoacán's participation on the market of avocado of Japan, 2002 - 2006

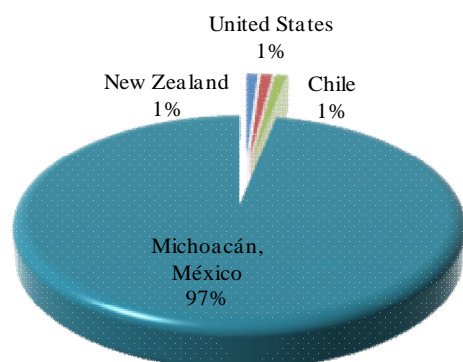
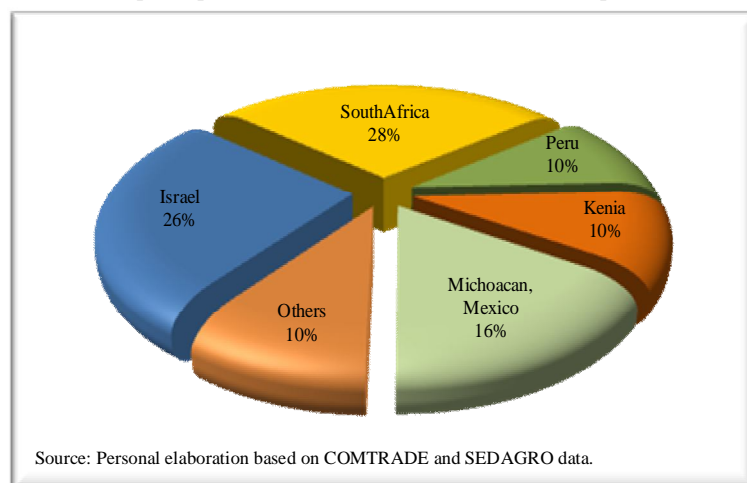


Figure 4  
Michoacán's participation on the market of the avocado of Europe, 2002 - 2006



## 2. Composition of the SIS

The analytical elements used to examine the functioning and dynamics of the SIS are the actors, the sources of innovation and the institutions, whose internal mechanisms are: the knowledge base, the technology and the learning, raw materials, and the demand. An SIS is composed of a group of agents who bring about marketing and non-marketing, or informal, relationships for the creation, production and sale of the products of the sector. In this manner the agents are individuals or organizations whose relationships obey a certain type of rules and that interact through specific learning processes, along with determined beliefs, objectives, and conducts (Malerba, 2004).

According to this perspective, with the proposal of generating an idea of the evolution and today's composition of the avocado SIS in Michoacan, in this section we describe the general manner of the actors of the SIS who have been generators or diffusers of innovations. To realize this analysis we divide the sector into three subsystems that act in a simultaneous manner: producers or cultivators of avocados, approximately 17,000, whose sales are 95% to the national market<sup>10</sup>; the second subsystem, packing businesses, of which there are around 100<sup>11</sup>; and the third subsystem, avocado processing forms located primarily in Michoacan, of which there are around 19. This group of businesses has begun to have a notable presence in the international market for over ten years.

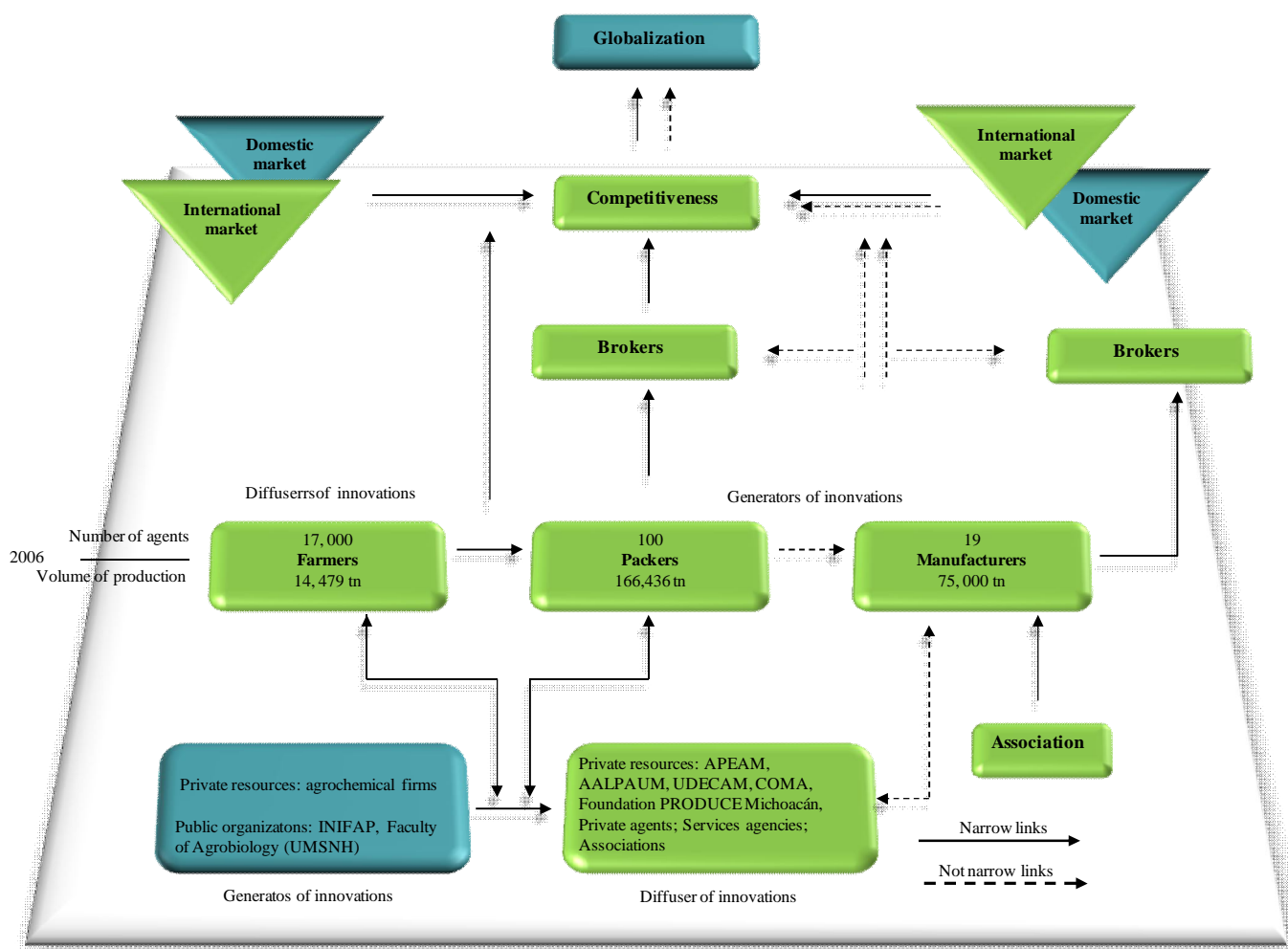
The avocado SIS in Michoacan is composed, for one part, by organizations that generate innovations according to private resources – agro-chemical businesses, organizations for public research – INIFAP and the Faculty of Agro-biology; and private sources – packers and processors. For another, it is incorporated by organizations which publish information of the innovations, grouped in private sources – association such as APEAM, AALPAUM, UDECAM and COMA; sales services – SEDAGRO, COMA, associations and the PRODUCE Foundation; and units of agricultural production, or the avocado producers (figure 5).

<sup>10</sup> The data for the number of producers was obtained directly from SEDAGRO.

<sup>11</sup> The number of packers is variable according to the source consulted. The quantity represented here comes from information published by COMA, while other institutions such as the PRODUCE Foundation of Michoacan holds that there are approximately 296 or 320 firms of this type (Sánchez, 2006).

Figure 5

**Michoacán: avocado sectoral innovation system, number of agents and volume of production**



Source: Personal elaboration.

### 3. Evolution of the avocado SIS: general view

There are signs in the evolution of the avocado sector that have been described by other authors (Bárceñas and Aguirre, 2005; Paleo, 2000, 2006; López et al. 1998; Sánchez Colín et al, 1999, 2003) that seem to have been examined from the focus of the SIS. The development of the avocado SIS emerges from a process of adaptation to contextual factors such as the imposition of tariff and non-tariff barriers and the adoption of quality assurance norms due to the modification in the international market demand which as required certain parameters for quality and health requirements for good agriculture.

These facts have occurred in both external and internal manners in the sector, which is why we divide its evolution in two periods, the first from 1941 to 1980 and the second beginning in the early 1980s until the present. This division corresponds to the appearance of tariff and non-tariff barriers on the part of the United States for the import of avocados, tied to the export performance of Michoacan avocados.

Furthermore, each epoch is related to the appearance of new actors and the reconfiguration of their innovative relationships. Certain modifications in the knowledge base made visible by research into avocado seed genetics affected by generating agents of innovations such as INIFAP, changes in sectoral and market demand, mostly international, and the forms of technological learning by the actors in the system.

Therefore, in reflecting over the evolution of the SIS, in the following section we describe the first stage, 1914 to 1980, in terms of the emergence of the actors, the regulations and the pioneering research. Following this, in Section 3.2 we examine the second period which began in 1980.

### 3.1 First stage: initial actors, commercial prohibition and pioneering research

We have taken 1914 as a starting point for the analysis of the evolution of the SIS given that in this year the United States prohibited the entrance of Mexican avocados into its territory, and as a consequence, in this lapse the structure of learning in the subsystems of producers became configured, becoming integrated into a primary net of agents that moved the SIS<sup>12</sup>. In this first epoch some of the producers involved in associations began to interact with one of the most important regional actors of the SIS: CICTAMEX. They also formed primordial nodes of the system: research institutes, producer associations, and governmental organizations whose functions were directed towards stimulating the production of avocado on a national level.

In documents about the history of the sector it is mentioned that in the beginning of the last century the California Avocado Society, founded in 1915, began exploration and collection of avocados in Mexico (Sánchez Colin, 1999). It is certain that in 1953 the Center for Scientific and Technological Research for Avocados of the State of Mexico (CICTAMEX) was created. With this research began for the genetic betterment of some species of avocado. These research projects began with the establishment of a phenological orchard called Las Animas in Ixtapan de la Sal in the State of Mexico. Researchers from CITAMEX, the California Avocado Society, and pioneering producers participated in the cultivation of fine varieties of avocado, located in Atlixco, Puebla. Other organizations such as the National Institute of Agricultural Research (INIA) also undertook research to save some varieties of avocado cultivated in Michoacan according to their flavor, size and yield (chart 2).

Chart 2

#### Evolution of the avocado SIS: initial actors in the first stage

Year of foundation	Agents	Activities
	California Avocado Society	Is today made of representatives from California, along with avocado . producers from other countries including Australia, Chile, Israel, Mexico, New Zealand, and South Africa
	Center for Scientific and Technological Researches of Avocados in the State of Mexico (CICTAMEX)	Research into generic improvement of some species of avocados
	Cupanda Cooperative	
	Association of Producers of Periban	Introduction of varieties of improved avocados in the municipality of Tacamb
	Uruapan – Agricultural Local Association of Avocado Producers (AALPAUM)	Link between producers and the government, publication of innovations
	CONAFRUT	Governmental organism for the stimulation of avocado production through the establishment of orchards with different varieties of avocado throughout the Republic

<sup>12</sup> Some authors mention prohibitions for the entrance of Mexican avocados into US territory being instituted by the Department of Agriculture there, even from 1905 (Bárceñas and Paleo, 2005).

Thereafter, in the 1970s, various members of the Cupanda Cooperative (founded in 1954) and the Association of Producers of Periban (APP, created in 1967 and made up of 50 associates) organized, along with CICTAMEX, the introduction of improved varieties of avocado in the municipality of Tacambaro, Michoacan (Sánchez, 2006). Particularly, the APP brought before the Mexican Fertilizers (FERTIMEX) a first concession for the sale of agro-chemicals in Uruapan, and in this way was able to offer the associates fertilizers at much lower prices than in the market. With this, the first agro-chemical or agricultural raw material store was founded in 1968 in the city of Uruapan (Sánchez, 2006). Along with these activities, the APP promoted the rental of storehouses and offices for the management of fertilizers, participated in the creation of other organizations such as the Regional Union of Avocado, Fruit and Vegetable Producers of the State of Michoacan, and the National Union of Vegetable Producers.

Then, in 1968, the Local Agricultural Association for Avocado Producers (AALPAUM) was organized in Uruapan. From its foundation, AALPAUM has divulged to its associates (approximately 100) new techniques for the conservation, improvements, rational soil use, and the efficient use of water. This was generated through the collaborative relationships between the groups of producers in the association and the INIFAP and by participating in the establishment of norms for the classification of agricultural products<sup>13</sup>

According to the above, during the 1950-60s the first agencies were established for the diffusion of technology, principally the Cupanda Cooperative and associations such as APP and AALPAUM that interacted with generators of innovations such as CICTAMEX and INIFAP. The links between these two groups of agents for the transmission of knowledge were informal, and there were no contracts for the provision of technology assessment services. It was only through extension that the agents who generated innovations brought the results of their research into agricultural material to the producers.

As a result of these relationships, in the 1970s the production of avocados such as superficial planting grew – in this period cultivation increased to 1,608 tons – and Mexican producers began to sell the fruit in various European countries such as France and Germany (Rodríguez and Becerril, 1993). Mexico also gained in that decade 18.5% of avocado production on a worldwide level and 21.6% on the American continent (chart 3).

Chart 3								
Avocado: world production by country and region, 1961 – 1980								
Country \ Period	1961 - 1970		1971 - 1980		1981 - 1990		1961 - 1990	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
Mexico	1,608	18.5	3,114	24.5	5,371	30.5	10,093	25.9
Brazil	1,170	13.5	1,424	11.2	1,279	7.3	3,873	9.9
Dominican Republic	1,148	13.2	1,296	10.2	1,355	7.7	3,799	9.7
United States	530	6.1	1,053	8.3	1,916	10.9	3,498	9.0
Peru	411	4.7	902	7.1	820	4.7	2,133	5.5
Haiti	436	5.0	538	4.2	607	3.4	1,581	4.0
Indonesia	383	4.4	449	3.5	626	3.6	1,459	3.7
Venezuela	504	5.8	431	3.4	455	2.6	1,391	3.6

<sup>13</sup> Other activities of the association are focused on purchases of machinery and articles for agricultural exploitation and transport of the products, the establishment of storehouses, silos, and grain driers for the benefit of the associates, and to communal sales of the members' products. Interview with Mr. Zamora and information from [www.aalpaum.org](http://www.aalpaum.org).



El Salvador	205	2.4	283	2.2	348	2	835	2.1
Congo	157	1.8	241	1.9	409	2.3	806	2.1
Ecuador	252	2.9	308	2.4	241	1.4	801	2.1
Israel	26	0.3	193	1.5	546	3.1	765	2
Others	1,862	21.4	2,503	19.7	3,640	20.7	8,005	20.5
Total	8,693	100	12,734	100	17,611	100	39,038	100
Region								
America	7,441.85	85.6	10738.64	84.3	12605.36	80.8	30785.85	83.01
Africa	659.47	7.6	1,052.65	8.3	1,404.24	9.0	3,116.36	8.42
Asia	560.86	6.5	871.39	6.8	1,246.27	8.0	2,678.51	7.23
Europe	4.73	0.1	35.07	0.3	255.70	1.6	295.50	0.80
Oceania	26.23	0.3	35.81	0.3	93.03	0.6	155.07	0.42
Total	8,693.13	100	12,733.55	100	15,604.59	100	37,031.28	100
Mexico/ America		21.6		29.0		37.2		
Source: Personal elaboration based on FAOSTAT data.								

From the 1960s the national production of avocado grew, and with it came the need to revise quarantine issues with the United States that from 1914 confronted avocado Mexican producers, particularly those from Michoacan. The objective was to introduce the fruit into new markets, although in this period there were no significant changes in the U.S. government's posture for the elimination of tax barriers for Mexican avocados, a situation we briefly describe in the following Section.

### 3.1.1 The persistence of prohibition

The transformations with regard to the ties between the agents of technology and its learning that have arisen in the system have been influenced, to a certain point, by sanitary and plant health regulations set by the principal market destination of the sector, the United States. This has meant that producers have responded with changes in order to adapt to the import prohibition on Mexican avocados. In fact, in 1914 the government of the United States prohibited the import of Mexican avocado with the argument of avoiding plagues such as the woodworm in the seeds.

The members of the avocado sector established two types of organization: that focused on a regional plant health campaign from 1990 to 1997, and the expansion of small private companies in the industry, made up of colleagues and members of the same family (Stanford, 1999). The first of these organizations arose in response to the avocado producers of Michoacan in face of the plant health prohibition of the entrance of avocados into the United States that was originated political plot sponsored by California avocado producers to defend their domestic market (Paz Vega, 1986, cited in Stanford, 1999).

The second type of organization came about in an effort to avoid the rigidity of the formal avocado producers organization, for instance the local agricultural associations that, in compliance with the Federal Law for Agricultural Associations of 1932, could not participate in commercialization nor in financing for cultivation. The result of this was that in 1990 the majority of the cooperatives, credit unions and associations established during the 1970s and 1980s ceased. When they disappeared, small private businesses, frequently made up of those who had been members, acquired their operations, trucks and packing installations, passing from the generation of agricultural associations and cooperatives to a generation of anonymous societies (Stanford, 1999).

With this, the economically solvent producers and packers counted on an efficient measure to face the challenges of economic globalization, but the small avocado producers of small farming cooperatives were not able to integrate themselves into the organizational structure of the anonymous societies, as they still operated within the old organizational models and were unable to compete in the national and foreign markets (Stanford, 1999).

Between 1941 and the first of the 1970s these societies began to function and consulate mechanisms for learning between the producers with respect to new practices of cultivation and the use of pesticides, which resulted in the control of plagues, and Mexico began to export to Japan, Canada and European countries as they then complied with quality and health standards of these nations (Roberts and Orden, 1996)<sup>14</sup>. Furthermore, in spite of the U.S. prohibition, the national avocado industry became more competitive. One study suggests that the cost of establishing an orchard in Mexico was 26% less than in California, which gave Mexico an advantage over U.S. production, as the costs for production per tree were \$600 to \$900 per acre in Mexico, compared to \$5,200 to \$5,700 per acre in California (American Farm Bureau, 1991). Also, over the year, wholesale prices for Mexican avocados for exportation are much less than those in California. As a consequence, the differential costs and prices are a strong base of economic competence for the Mexican industry (Roberts and Orden, 1996).

At the beginning of the 1970s the Mexican government asked for corresponding permissions for U.S. importation of Michoacan avocados, a petition that was denied by the U.S. government, allegedly because it had been shown in the literature that Mexican avocados were hosts for a great quantity of plagues, including a woodworm in the seed and fruit flies.

The following decade was a period in which the Mexican government did not make any solicitation of the U.S. government. However, in the beginning of the 1990s, negotiations began in force by NAFTA, the agreement between Mexico and the United States, which included the removal of non-tariff barriers for all agricultural products, with a period of 15 years of adjustment for the more sensitive properties. NAFTA also included sanitary and plant health regulations related to the commerce of agricultural properties. Thus, from November 1997, avocados from Michoacan once again began to enter the United States, particularly in Alaska. Then, in February 1997, the prohibition was partially raised when the Animal and Plant Health Inspection Service (APHIS) published the final ruling that permitted the import of Hass avocados from Michoacan into the United States, with three conditions: i) the avocados from Michoacan exported to the United States must be produced only in the municipalities of Uruapan, Periban, Tancitaro and Salvador Escalante, whose orchards were declared free from quarantine plagues according to APHIS research; ii) the exportation of avocados from Michoacan were only to be temporary, and only permitted during the period from November to February, the winter season in Mexico; and iii) the import of Hass avocados produced in Michoacan could only be made to the northeast of the United States, which included the 19 States of Connecticut, Delaware, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin, the area of Washington, D.C. (USDA, 1997)<sup>15</sup>.

---

<sup>14</sup> In 1982 a group of producers and packers from Michoacan sent their first avocado cargos to the European market, where sales were made under the ruling of a commission through distribution centers. Thereafter different countries on the continent assigned avocado taxes ad valorem at different levels. According to Paz Vega (1986), these taxes established the quality standards for the fruit and its acceptance according to the Generalized System of Preference in the European Economic Council.

<sup>15</sup> On February 5, 1997 the norm Publisher in the Official Diary of the United States authorized the import of Mexican avocados to 19 States in the country. In the negotiations, the Avocado Commission of the State of Michoacan participated with the General Direction for Vegetable Health and researchers from INIFAP and the Postgraduate School of the Universidad Autonoma de Chapingo. The technical information required by the United States as to the presence, distribution and quarantine plague damage of avocados in order to establish actions and strategies was generated and

The avocado export businesses produced knowledge for the development of an infrastructure for the production, packing and transport services. As the export of avocado expanded to Europe and Asia, particularly to Japan, the exporters from Michoacan began to demand the elimination of barriers for the introduction of avocados into the United States. For the producers from Michoacan, the plant health prohibition maintained by the government represented a political plot initiated by the California producers in defense of their own market (Paz, 1986). For its part, the Avocado Commission of Michoacan maintained an office in Uruapan and Washington, D.C. with the end of promoting negotiations to eliminate said prohibition. This effort was reinforced by regional programs to eradicate the woodworm in the seeds, which was coordinated by local producer organizations, the SAGARP, Vegetable Health, and the Center of Regional Research of the South Pacific (CEFAP) (Gutiérrez, 1991).

### **3.1.2 The first steps in the research and beginning the connections**

In the period from 1914-1980, the avocado sector was tightly bound with research, principally that realized by CICTAMEX, a research institution located in the State of Mexico. In 1969, in avocado trees cultivated in the State of Mexico the effect of an excess of calcium, clay and saltpeter in the soil was seen. A search was begun for a place in which the climate and soil were appropriate for continuing the experiments and research into the Hass variety, and such a place was found in Coatepec de Harinas in the same State. They selected some of the best plants and moved them to Michoacan and began the formation of a germ plasma bank. Also in the avocado orchards in Coatepec Harinas the first experimental work began in the search for new varieties of avocados such as Hass and Fuerte. Thereafter, with the end of developing genetic variation through the selection of seeds, at the end of the 1970s the first plantings of the varieties of Hass avocados were made for the collection of their seeds.

One of the pioneering actors in this research was the Faculty of Agro-biology of UMSNH, which began in 1956 as a vocational school for agro-biology, and in 1961 became the Faculty of Agro-biology President Juárez. From that time it has produced professionals who are assessors for producers as much in new plantations as in those already established. One of the principal mechanisms used by the Faculty of Agro-biology has been the realization of many theses referent to the aspects of avocado cultivation. In the period from 1971 to 1999 there were 63 Bachelor's theses over the principal themes of primary and secondary plagues related to chemical control, the dynamics of population, the biology and habits of plagues such as the red spider, small seed woodworm, branch woodworm and leaf sapper, avocado illness and fertilization techniques. In particular, 37% of these theses deal with techniques related to watering, plant production, technological levels of production, fenology,<sup>16</sup> harvest, and avocado production factors (Aguirre and Bárcenas, 1999). Some of the thesis results have been applied by producers, for example, from 1971 to 1998 thesis writers from the Faculty of Agro-biology have worked with producers in three regions in Michoacan of Uruapan, Periban and Tacambaro, and in other places such as Ixtapan de la Sal, and in the State of Mexico. There have been a total of 162 joint works with producers, of which 81% were realized in the region of Uruapan, 11% in Periban, and 7% in Tacambaro<sup>17</sup>.

From the previous information it is possible to reconstruct a first map of the avocado SIS in Michoacan (figure 6). The stage from 1914 to 1980 must be considered, although the prohibition of

---

proposed by the Faculty of Agro-biology, where information had been gathered about avocado plagues, which was very important in supporting Mexico's solicitude to the government of the United States in order to enter the market.

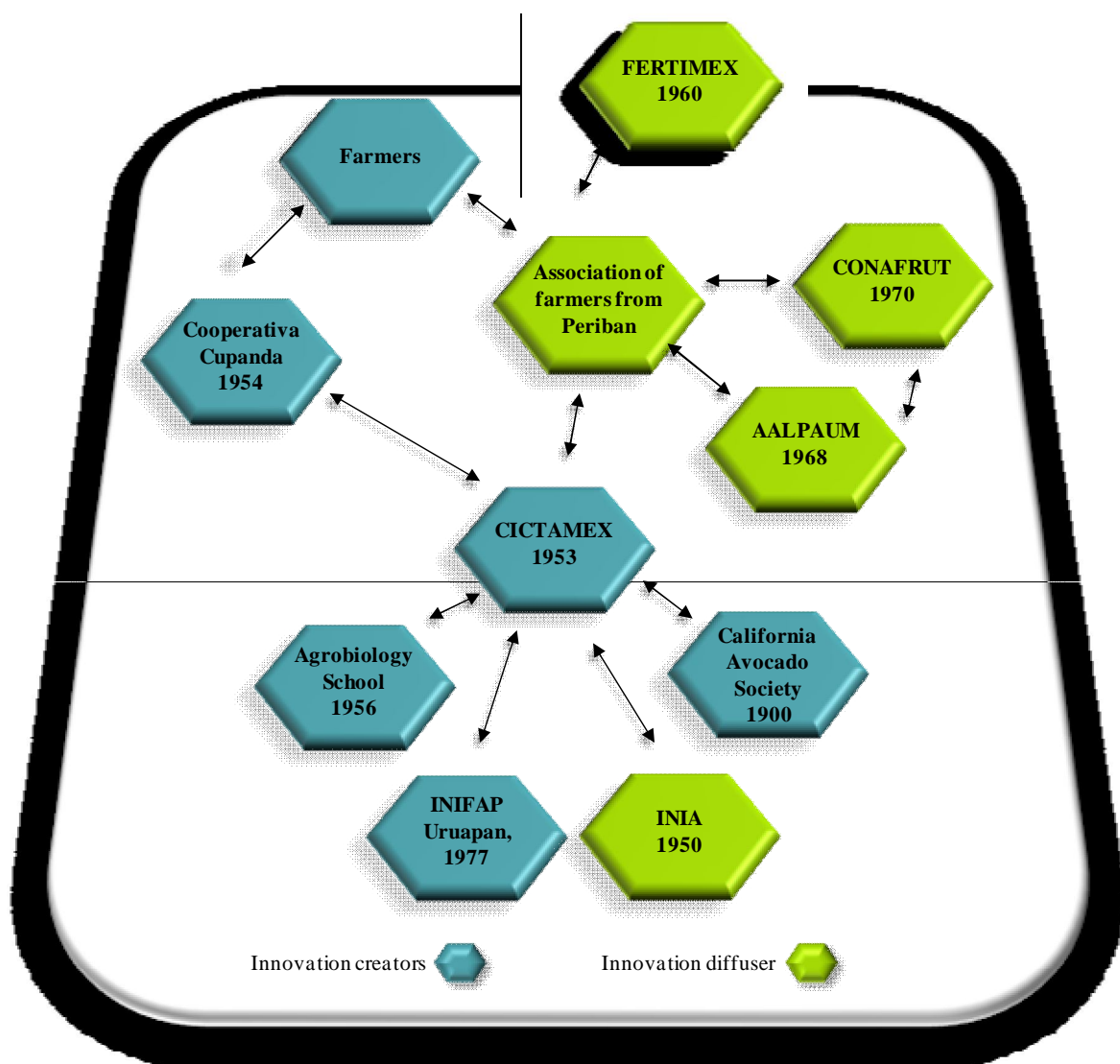
<sup>16</sup> Fenology is the part of meteorology that studies atmospheric variations as they relate to plant and animal life.

<sup>17</sup> The region of Uruapan includes the municipalities of Nuevo Paragaricutiro, Ziracuaretiro, Tancitaro, Tingambato and Taretan; Periban includes the localities of Periban, Tinguindin and Los Reyes, while Tacambaro integrates Tacambaro, Ario de Rosales and Salvador Escalante.

the entrance of avocados from Michoacan into the United States was maintained, the volume of export of the fruit increased and at least five types of organizations were founded or networks were begun between those in existence. These aided in the innovations of the SIS and at the same time stimulated various forms of technological learning between the producers and improving their capacities. These were universities and public research centers, those offering services, agricultural production units or orchards, and private organizations and associations.

Figure 6

First period: main nodes and SSI creation



With the establishment of relationships between private organizations such as CICTAMEX and the California Avocado Society located in Santa Paula, California, and public ones such as INIFAP, the Faculty of Agro-biology, CONAFRUT and INIA, networks were created for the development of improved seeds and their transference to producers, principally under the initiative of the Cupanda

Cooperative located in Tacambaro, Michoacan and the Association of Avocado Producers of Periban, Michoacan, created in 1967.

Private resources, as diffusers of innovations have also been important in the formation of the SIS, principally through the creation of collective organizations or associations whose principal proposal has been the transference of new varieties of seeds and agricultural practices amongst the union members, as in the case of the Cupanda Cooperative and other such as AALPAUM and APP, who have distributed amongst their associates, through reunions and information bulletins such as “El Aguacatero”, knowledge about new plantation methods, fertilizer and pesticide dosages, and methods for control of plagues and irrigation.

The network between private organizations, principally associations, and the research institutes such as CICTAMEX and INIFAP, were promoted by the need to enter the United States market, and comply with the requirements of that country for the safety of the avocados. This has generated diverse mechanisms of learning that have permitted the producers to accumulate knowledge and technological capabilities.

It is worth remembering that technological learning is the accumulation of experience that conforms to the tangible and intangible cultures of the businesses. As we have seen, technological learning generates changes in productive and organizational routines in the businesses, and their modifications are related to the mechanisms of intra-business and inter-business coordination and interaction. In this manner, the firm learns about measures for storage, administration and movement in a connection of experiences, abilities and knowledge, although individual habits and even collective ones reinforce productive rules and are in turn strengthened by them. These play a special roll in proportioning to the members of a corporation a cognitive structure for interpreting data, fixing intellectual habits or routines, and transforming information into useful knowledge.

Thus technological learning has a direct relationship with the production structure, given that it occurs during routine activities of production, distribution and product consumption in a way such that the experience acquired in these three activities is a source for learning and for the innovation process.

To demonstrate what the basic agricultural technological and innovative are, we have classified them into seven types: i) organizational work innovations; ii) agricultural administration and agronomic gestation, whose objective is to adapt to the agro-business system in the matter of administration of productive organization. Amongst the technological measures in the matter of administration are found mechanisms for post-agricultural innovation referent to the market and the manners of selling the products produced<sup>18</sup>; iii) information systems, information sources from Internet and the diffusion of new technology through governmental extensions or private business that promote the use of information systems in the rural medium; iv) chemical innovations<sup>19</sup>; v)

---

<sup>18</sup> Agronomic work consists of the instrumentation of strategies for improving production. These are activities such as orchard design, herbal proposals in terms of qualities of varieties or species of vegetative materials, rotation of crops, climatic adaptability, production organization, and level of resistance or immunity to sicknesses or plagues. In general, solutions of themes related to plant health and good agricultural practices are looked for.

<sup>19</sup> Beginning with the green revolution, the Mexican countryside has gone through significant change that is reflected in the productive and socio-cultural structures as much in the farming economy as in agricultural business. This revolution developed during the post-war period and emerged with the incorporation of fertilizers, highly productive seeds, agro-chemicals, tractors and harvesters, amongst others, in package form, or in other words, integrated and controlled forms of application of these products with the end of raising productivity. Modern forces in agriculture brought with it development through the use of diverse chemical elements made in the laboratory to produce greater production. Chemical innovations refer to the new generation or application of chemicals found in nature or man-made chemical substances, with the end of being manipulated or induced to the plants so that they react to the productive expectations of the farmers. Amongst these pharmacological chemicals are included: pesticides or insecticides, fungicides, herbicides and other fertilizers plant hormones. Fertilizers are also important nutrients for fruit development, and can be found

mechanical innovations, some of the most common of which are the tractor, seeders, harvesters, separators and tillers. Most of these machines are used in the treatment and tilling of the land in order to oxygenate it, for watering purposes, or simply to make planting easier; v) bio-technological innovations<sup>20</sup>; and vi) genetic innovations.

According to the above, the relationships between producers and associations, governmental organizations such as SEDAGRO, and research instates (INIFAP and the Faculty of Agro-biology) have resulted in the creation of diverse mechanisms of technological learning and innovation while also improving the ability to compete with other markets (chart 4). From field work in this area we find that at least seven mechanisms for technological learning. Amongst these, the cooperative purchase of agricultural products has brought about innovation in the organization of work that has resulted in the reduction of costs, principally for the medium-sized producers in the associations. Also, the acquisition of fertilizers and agro-chemicals has brought about the cultivation of avocados with healthy characteristics, and because of this, avocados that are certified for export according to the norms and agricultural practices such as those in the manual *Good Agricultural Practices (BAP) and Good Practices of Management (BPMP) in production and packing process for fresh fruit and vegetables for human consumption*<sup>21</sup>. Also, according to these norms, the producers, through the associations, have designed, developed and acquired packaging to satisfy the needs of the clients. In effect, the official Mexican norm NOM-128-SCFI-1998, published in June 1998, establishes the commercial information for avocado packaging<sup>22</sup>. According to BAP, the mechanical innovations, principally the adaptation or purchase of machinery and equipment, has allowed for the satisfaction of quality needs for the cutting and harvest of avocados<sup>23</sup>. Also, as a result of the relationship of the producers with INIFAP and the Faculty of Agro-biology the certification of orchards for export, through the elimination, prevention and control of plagues has been achieved, along with implementation of improved seeding practices.

Chart 4				
Producers: mechanisms of technological learning according to innovation and results				
Mechanisms of technological learning			Innovation	Results
Participation	in	national and	Monitoring	Improvement of planning systems

naturally in the soil, as well as can other nutritive fertilizers that offer good cultivation development through artificial chemical manipulation.

<sup>20</sup> In the agricultural sector, bio-technology for plants is changing agricultural techniques in the improvement of characteristics of both cultivation growth and productivity. Cultivations modified genetically are being evaluated and controlled in field tests. On the other hand, cultivation which is resistant to some plagues permit the reduction of environmental damage by decreasing the use of chemical pesticides and herbicides, and enormously reduces losses due to insects or other plagues through the use of bio-insecticides that in turn are not environmentally aggressive (Solleiro and Castañón, 1999).

<sup>21</sup> The manual described good agricultural and management practices that must be applied in production or packaging. The proposal is to offer assessment to the producers and packers for the reduction of biological, chemical or physical risks that might produce health dangers.

<sup>22</sup> The commercial information of the packaging must include the name and address of the producer and packer, generic name of the product "Avocado", product variety. Classification level, average content weight in kilograms, name of country or region of origin. The labeling must be stuck to or printed on the front part of the packaging.

<sup>23</sup> This established that the cultivated product must be collected in a manner that World maintains its harmlessness, which meant that all of the tools and containers utilized in the harvest and enter into contact with the product must be washed and disinfected, and that storage for the harvest tools must be built. In the particular case of the containers destined for the product, these must be used exclusively for this end, for which the establishment of a program for the substitution and or repair of damaged containers is recommended. The vehicles destined for the transport of the harvested product to the packing plant must be given a documented cleaning procedure which must be shown to be valid during registration.

international fairs		
Communal purchase of raw materials	Administration of communal purchases	Reduction of costs
Acquisition of fertilizers and agricultural chemicals	Cultivation with communal characteristics	Avocados certified for exportation
Design and development and/or acquisition of packaging	Adaptation of packaging	Fabrication of packaging according to client specifications
Design and construction of machinery and equipment and/or their purchase	Improvement of existent machinery and equipment	Adequate machinery and equipment for harvesting
Relationship with universities (INIFAP, Faculty of Agrobiology)	Elimination, prevention, and control of plagues; improvement in planning practices, organic management of orchards	Orchards certified for exportation
Training programs (INIFAP, Faculty of Agrobiology)	Systematization of training <i>in situ</i>	Integrated cultivation maintenance; publication of planning and harvesting manuals,
Quality systems (national and international norms)	Biology, genetics, mechanization of cultivation, freedom from plagues	By agricultural extension programs: training, reduction of costs
Linkages with Foundations	Administration and cultivating improved for small producers	By agricultural extension programs, transference of knowledge about avocado phenology and nutrition; Trained technologists in integrated avocado cultivation management and publication of the Technical Guide. Publication of a catalogue of organisms to combat tree plagues and illnesses.
	Recovery and conservation of the ecosystem	Menu of technological sales to improve the use of forestry and water resources
	Repositioning strategy and reordering of national market supply	Development of stock centers and logistics of market penetration
Linkages with research national and international centers (INIFAP)	Identification of avocado genotypes and their adaptation in zones of cultivation	Selection of Hass elite avocado genetic material with desirable characteristics
	New fertilizer formulas and their application to trees in production	Up to 16% savings in communal costs for fertilizers
	Integrated management of plagues	Rise in production of exportable and agrochemical savings
	Development of techniques and calendarization of fertilizer application for plague control	Improvement in fruit quality for exportation; reduction in agrochemical application
	Nutritive and sanitary management in orchards to avoid deterioration of avocado quality; post-harvest management of the fruit	50% rise in income in sales of avocados for exportation
Client provider relations	Administration of communal purchases	Reduction of costs; market satisfaction
Information systems	Computerized systems for monitoring economic information	Use of intelligence system for the market
Producer visits to other countries	Adaptation of planning and harvesting systems	Improvement of planning and harvesting systems
Monitoring of market tendencies (organic)	Creation of information system	Improvement in knowledge of national and international market tendencies; successful negotiations for the commercialization of avocados in foreign markets
Linkages with government organisms	Cultivation of avocados with desirable characteristics	Plague-free orchards certified for exportation
Source: Personal elaboration based on INIFAP.		

In the 1970 there began a new stage for avocado SIS, as during this second epoch new agents appeared – COMA, the PRODUCE Foundation of Michoacan, FIRA, and the Department of Vegetable Health of SEDAGRO, and the producers developed more links, promoting additional learning and capacitating mechanisms. Negotiations with the government of the United States were also resumed to eliminate the prohibition of the import of avocados, and with this the participation of Mexico, particularly of Michoacan, was increased in worldwide sales of the agricultural product, as we will see in the following Section.

### **3.2 Second stage: new actors, the beginning of deregulation, and new research relationships**

In the period that began in 1980, the avocado SIS was changed by the appearance of new agents who reinforced collaborative relationships within the system. In effect, there arose a network of corporative relationships in the form of organization of innovative activities between the actors created in the previous stage from 1914-1980, and the appearance of new associations and complementary services in response to sectoral demand.

This second stage initiated new research by institutes such as INIFAP and the Faculty of Agro-biology and the diffusion of knowledge to the producers through extension. For example, from 1998 INIFAP annually attended to between 80 and 100 producers on their own orchards, helping them in seed conversion, watering and avocado harvesting with innovations developed by that institute<sup>24</sup>. Even so, the links between the producers and the two research centers mentioned were developed slowly in the first stage, given the lack of producer organization, and only for the intervention of the associations was the establishment of networks possible.

In the period that began in the 1980s, the relationships between the producers and the research centers to comply with plant health and quality norms that the United States authorities required were strengthened. In addition, the creation of business associations for avocado packers and sellers and governmental dependencies began. For example, in 1990 the Avocado Packers Union of Michoacan (UDECAM) was initiated, and today has 61 members. The creation of this association was originated by five members whose proposal was to found an organization able to coordinate actions to comply with the norms for harmlessness of the avocado, to help the members in market options with market research, to bring about publicity and promotional campaigns in the country, to regulate avocado production and commercialization, to develop research and information systems to obtain results and quality improvements, to help to stabilize prices, and to make arrangements with the Federal, State and Municipal governments<sup>25</sup>. Also, UDECAM worked together with the Avocado Packers Union of Periban A.C. to buy and sell boxes, nails, packing tape, corners and cutting materials, along with developing new commercial projects.

In the 1990s other associations also appeared, such as the Producers and Packers of Avocados for Export of Michoacan (APEAM) and the Mexican Avocado Exporters and Packers, A.C. (ASEAM). There were other organizations whose function are to represent and plan the integral development in the chain of avocado production, such as the Avocado Commission of Michoacan (COMA)<sup>26</sup>, and from the TLC firm there was established in Uruapan packing companies from the United States, such as Calavo, Mission de Mexico, Fresh Pack, and Del Monte, who, given their commercial abilities in the international market, pushed Mexican exports (Fig. 7)<sup>27</sup>.

Thus in the new configuration of the subsystem of producers principally four groups of actors characterized by close collaborative relationships between themselves intervened. The first was made up of three associations or councils; AALPAUM, APEAM, and CONAPA. The second was made up of two local research associations, INIFAP and the Faculty of Agro-biology, and one regional, CITAMEX, whose activities were directed principally towards research into the cultivation of avocado, although recently they have made up interdisciplinary and inter-institutional teams in the study of organic and sustainable cultivation of the fruit.

The third group was formed by promotional institutions and research services such as the PRODUCE Foundation, an organism of SAGARPA, that aids in innovation for the integration of chains of value in the agricultural, livestock, forestry and fishing sectors, laboratory services for

---

<sup>24</sup> Interviews with Dr. Ignacio Vidales, INIFAP, Experimental Center in Uruapan.

<sup>25</sup> Interview with Mr. Morales Sierra, President of UDECAM:

<sup>26</sup> Integrated by the State councils for avocado producers of the States of Mexico, Morelos, Puebla, Mayarit, according to information given by Mr. Rito Mendoza of the Michoacan Avocado Commission.

<sup>27</sup> Although in 1984 the first formal parking was created in the region (Sánchez, 2006).



chemical analysis of soils, water for watering, the creation of composts, and also the diffusion of technology produced in the State. Other institutions involved in the third groups of actors are governmental, such as the State delegation of SEDAGRO, that intervene in the subsystem with promotional and commercial activities for products and plant health campaigns, amongst others.

The plant health campaigns have particularly been brought about by the Local Committees for Vegetable Health (JLSV)<sup>28</sup>. These are governmentally intermediated in the supervision of the compliance of sanitary and plant health regulations by the producers with the proposal of certifying that the avocado orchards are free from plagues and that the harvested fruit can be sold for export. In the period from 1997-1998, the areas certified for export were 1,499 in four municipalities, and this number rose in 2002-2003 to 21,597 in nine municipalities. Thus exports rose from 50,000 tons in 1997 to 94,000 tons in 2003.

Finally, the fourth group is on the second level, BANCOMEXT, whose work is directed towards international promotion of products and professional training courses for exports, and FIRA, who authorized credit for agricultural loans and repairs.

The relationship of the producers with these groups of agents varies in intensity and is complementary. With the promotional institutions, for example, such as the PRODUCE Foundation, in the area in which this organism concentrates, analyses and proposes projects with governmental budgeting and obtaining funds for the producers, packers or the party interested in realizing the projects, the Foundation absorbs most of the research projects into avocado cultivation, and directs the researchers of the different centers such as INIFAP, the Faculty of Agro-biology, or whatever other institution that contributes knowledge for the solving of particular problems. Today AALPAUM as well as PRODUCE work together with INIFAP to determine the fenology for the State of Michoacan, to characterize the avocado's flowering development and opportune times for harvest. They also collaborate in research to establish patterns for the planting of avocados that are resistant to salt, clay, low humidity, and drought.

AALPAUM has worked together with SAGARPA in the creation of plant health norms. There is an area of this organization that manages and coordinates, along with other local governmental offices, normative areas, along with those of the producers, in the creation or modification of rules, as in the case of the plant health norm FIT066 that specifies the rules for plant health management and avocado mobility. In the creation and modification of this rule the Avocado Commission of Michoacan (COMA) participated along with Local Committees for Vegetal Health and producer and packer associations, amongst other agents<sup>29</sup>.

The relationships of the producers with research institutes such as INIFAP occur in an indirect manner through technical services. The technical services agents are individuals who work for the agro-chemical businesses and diffuse amongst the producers the results of INIFAP research<sup>30</sup>. The relationship of INIFAP with associations such as APEAM is beginning to strengthen, as only in 2005 was an agreement for collaboration between both parties signed with the end of solving the problem of black spots on avocado peels that appeared during their transport by boat.

---

<sup>28</sup> The State Committee for Vegetal Health of Michoacán (CESV) is an auxiliary organism for statewide coordination through the Secretariat of Agriculture, Ranching, Rural Development, Fishing and Food Industry (SAGARPS) in the development of plant health campaigns and vegetable health programs and/or actions. Other auxiliary organisms are the Local Committees for Vegetal Health (JLSV) which is coordinated by CESV. There are organizations of avocado producers who act as auxiliaries to SAGARPA in the development of plant health activities. The JLSVs include the avocado producers of each municipality. The technical personnel of the auxiliary organisms, together with the avocado producers, verify compliance to the plant health norm, taking random samplings and making recommendations when there is the presence of quarantine plagues. They also verify the use of authorized insecticides in the programmed work, and for the general cleaning of orchards.

<sup>29</sup> Interview with Mr. Rito Mendoza, President of COMA.

<sup>30</sup> Interview with Mr. Ignacio Vidales, INIFAP, Experimental Center in Uruapan.

With respect to financial institutions, there is no direct relationship since the financial crisis of the 1990s because the producers could not pay their debts. For example, although FIRA has a budget and promotes its loan programs, in reality an avocado producer can rarely meet the requirements. The impact of the crisis also affected the confidence in these institutions given that the interests charged made it difficult to comply with payment, as did the bureaucratic schemes for getting credit<sup>31</sup>.

According to Mr. Zamora, ex-President of AALPAUM, there is no optimal program for research into the avocado sector, and because of this there is no scheme for the transference of knowledge from the research institutions to the producers. According to INIFAP the transference of knowledge from this institute to producers is realized in an indirect manner through specialized sales technicians who, as can be seen in Fig. 6.8. That is to say, the personnel who work in the businesses that sell agro-chemicals, established principally in Uruapan, participate in courses offered by INIFAP and practice their knowledge of the results of the research done at the Institute. In this manner, they diffuse amongst the producers new production techniques. For at least four years the direct relationship between INIFAP and the producers has been strengthened, but it is incipient, with the distance between the two agents being developed in an imperceptible manner which is insufficient for two principal reasons. Firstly, the lack of knowledge on the part of producers about the activities that are developed at the Institute, and secondly, the lack of confidence in the results obtained<sup>32</sup>.

On the other hand, the relationships of the associations with their members with respect to training are close. Although there are no systemized programs for training, knowledge is imparted or information is transmitted to the producers about new forms of cultivating avocado through conferences about products, machinery, and trips are financed to recognized areas where avocados are cultivated, both within the country and abroad<sup>33</sup>. Additionally, the associations communicate with the producers both directly and over the telephone, through the office of the association, about informative reunions, communication about products or events, assemblies, and through technicians who go to the orchards (direct communication). Internet is also employed, as is fax, along with written tracts such as the bimonthly bulletin (*El Aguacatero*). There is also a weekly radio program which broadcasts national and international market conditions for the price of avocados and predictions or data about climate conditions in the region<sup>34</sup>.

It is important to note the indirect relationship that exists between producers and research institutions, which is brought about through the Avocado Commission of Michoacan (COMA)<sup>35</sup>. The relationship of this organization with producers and other agents is realized through the Leader Plan<sup>36</sup>. For example, research institutions such as INIFAP, the Postgraduate School or the Faculty of

---

<sup>31</sup> In this aspect, there was agreement in different interviews, equally in those with Mr. Zamora, ex-President of AALPAUM, as with Mr. Rito Mendoza of the Avocado Commission of Michoacan.

<sup>32</sup> Interview with Dr. Vidales, Director of the experimental center in Uruapan.

<sup>33</sup> Interview with Mr. Zamora, ex-President of AALPAUM.

<sup>34</sup> Interview with Mr. Zamora, ex-President of AALPAUM.

<sup>35</sup> COMA principally Works with producers through organizations or local committees for vegetal health. It is an organism whose function is to lead and connect the different producer organizations, and its representation is statewide. COMA participates in the State Committee for the Avocado Product System (CESIPRO), together with other organizations such as UDECAM; APEAM, nursery unions, harvesters, transporters, and those who offer technical services. This Committee is made up of representatives of sectors whose function is to plan the different aspects of the avocado industry.

<sup>36</sup> This plan is an action guide that directs avocado producers and packers in actions directed towards the strengthening of good practices in the production, harvest and packing of avocados. It is the result of the consensus of producers', packers' and associations' demands, with the objective of identifying the competitive factors in each step of the subsystem of avocado production, and also to put forward a set of concrete actions which guarantee the consolidation of all of the participants into long term rentable economic units.

Agro-biology, realize specific investigations derived from said Plan. This includes the collaboration agreements between COMA and the research institutions which are established based on research demands set out in that document. Within this working framework the researchers from institutions that are part of the productive system<sup>37</sup>, such as INIFAP, the Sánchez Colín Foundation, the Faculty of Agro-biology, or the Postgraduate School, turn to the Commission in order to participate in the mediation of competitive oppositions, and in the solution of specific problems. This implies that whatever proposal that comes from CONACYT or the PRODUCE Foundation from researchers must be evaluated by the productive system in order to be undertaken<sup>38</sup>.

A successful case of the relationship between COMA and foreign research institutions was the study of the fruit fly. This collaborative agreement was brought about with the end of penetrating the United States market. The Department of Agriculture of the U.S. asked for the study to prove that the avocados from Michoacan did not host the fly, and along with COMA contracted a scientist from INE, Dr. Aluja, to undertake the investigation. The results demonstrated that the avocado did not host the fly, and producers could enter the United States market (Aluja, 2003)<sup>39</sup>. Furthermore, the Commission has collaborative agreements with CONAFRUT for environmental, water, soil and forest care.

In all of the Local Committees for Vegetal Health (JLSV) there are agronomical engineers dedicated to solving plant health problems in orchards, and also to the diffusion of techniques for risk prevention and fertilization. Although the JLSVs have become diffusers themselves for this technology, the most usual form of transmission of innovations as been the radio. The JLSVs share with producers the requirements for international protocols, for example the sanitary and plant health demands of EUREGAP, a European treaty that requires health protection in production, environmentally friendly cultivation and worker safety, among other requirements. To successfully meet good agricultural practices, the JLSVs have developed a program through which new techniques for cultivation, fertilizers and the results of water studies are transmitted to producers.

Also, when the JLSVs consider that an orchard or municipality is free of plagues, it is certified for exportation<sup>40</sup>. This process began in 1990 with the negotiations between SPHIA and SAGARPA to allow the entrance of avocado into United States territory, and the first certifications began in that year with the participation of Vegetal Health, through local committees and the Faculty of Agro-biology of UMSNH, actions that were reinforced from 1993 with the creation of the State Committee of Vegetal Health. During 1994 and 1995 federal and state funds were made available with the same State Committee, and from 1996 aid was authorized through the program of the Farmers' Alliance that had added the publication in that year of the Official Mexican Norm NOM-066-FITO. In 1995 this group participated in strengthening plant health activity with avocados through the application of the Plant Health book. The JLSVs, operating on a municipal level, had implemented and administrated all of the health and plant health campaigns for the certification of orchards and had declared them free from plagues. The inspectors of APHIS supervised the operations of the local health and plant health campaigns, and showed confidence in the ability of

---

<sup>37</sup> With the promulgation of the Law for Sustainable Rural Development of November 13, 2001, the conformation of the Product System Committee was defined, both for agriculture and fishing, with forums for specific concentration on each branch of production.

<sup>38</sup> Interview with Mr. Rito Mendoza, President of COMA.

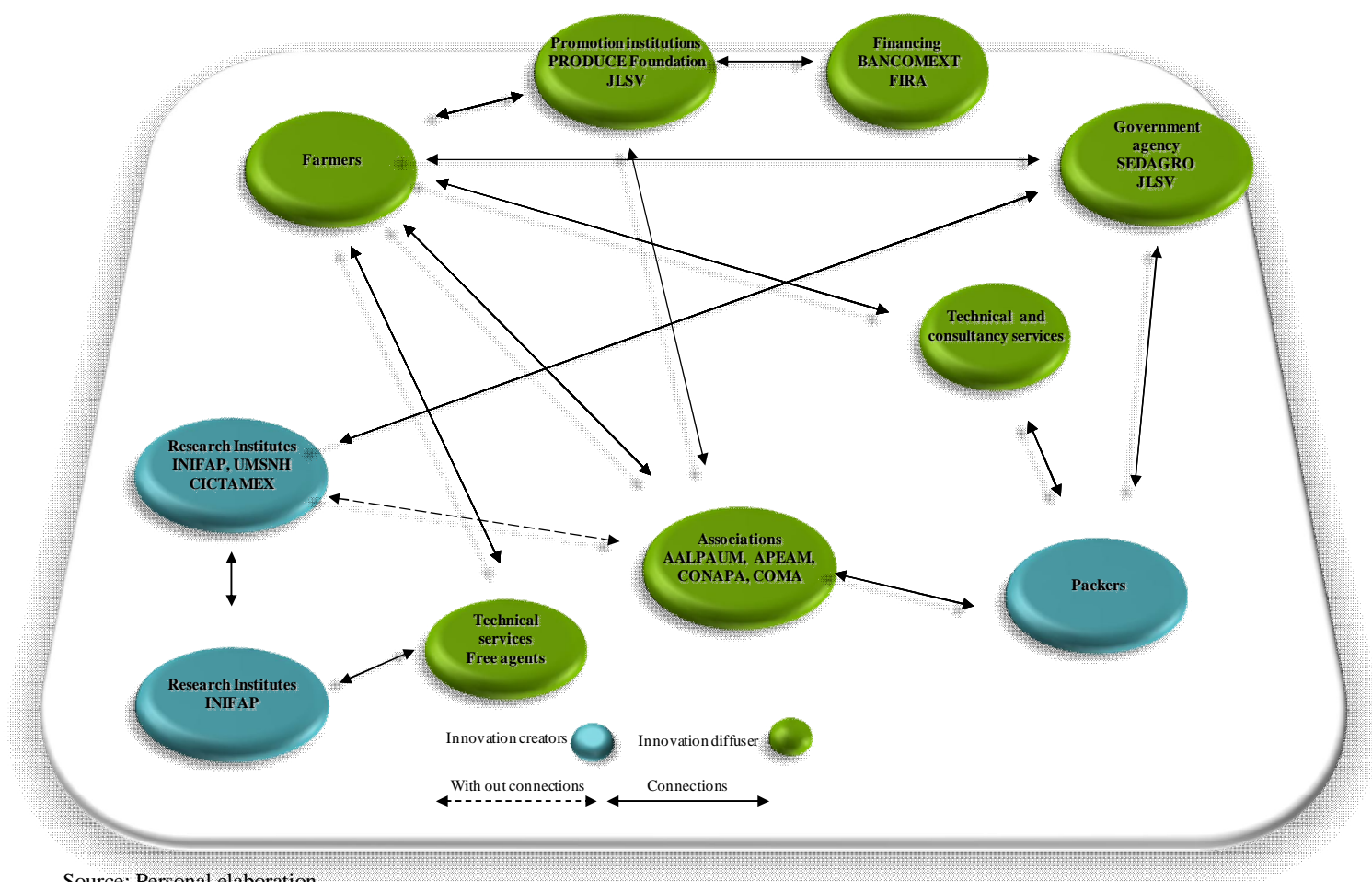
<sup>39</sup> Interview with Mr. Rito Mendoza, President of Coma.

<sup>40</sup> According to the update of NOM-066-FITO-2002, the municipalities of Michoacán which have been declared free from woodworms in the seeds are: Uruapan, Periban de Ramos, Tancitaro, Salvador Escalante, Nuevo Paragaricutiro, Ario de Rosales, and Taretan. In January 2004 the municipalities of Los Reyes and Apatzingan were incorporated, and in August of the same year Tacambaro was included. Likewise, in January 2005 the municipalities of Acuitzio and Tinguindin were declared free of woodworms (Salazar, Zamora and Vega-Lopez, 2005).

Mexican producers in complying with the standards<sup>41</sup>. The avocado industry in Mexico adopted the established standards for the first time. On the local level the JLSVs were created as a governmental intermediary between producers and the government of the United States to supervise compliance with the APHIS regulations, beginning a circle in which high export returns were obtained. The interaction between associations and governmental offices are the predominate mechanism for technological learning on the part of the producers, and has permitted them, through representation in the associations, to significantly improve the cultivation and post-harvest management of avocados. Thus the certification of orchards for export and control of plagues has become more attractive. For example, in the period of 1997-1998 orchards certified for export have increased from 1,499 in four municipalities to 21,597 in nine from 2002-2003, and foreign sales have risen from 50,000 in 1997 to 94,000 in 2003 (Fig. 7).<sup>42</sup>

Figure 7

**Second period: Michoacan avocado sectoral system of innovation**



Source: Personal elaboration.

<sup>41</sup> Interview with Mr. Rito Mendoza, President of COMA.

<sup>42</sup> Interview with Mr. Jorge Morales Sierra, UDECAM:

### 3.2.1 Prohibitions are not forever

Sanitary and plant health norms or regulations have been a fundamental element that has modified the development of the SIS since the 1980s in that their creation, along with generating competitive pressure, has favored innovation in the producers businesses. However, the process of producer development has involved higher costs of investment, which includes getting an orchard certified for export of its produce by the JLSVs and the expense of belonging to associations with international market connections, principally with the United States, costs which packers also see. This has raised the barriers for many producers for entrance into the avocado export industry.

As a part of the negotiations with NAFTA, in the 1990s avocado producers from Michoacan again solicited permissions to enter the United States market, but for almost five years, the government of the United States, along with the California avocado producers, upheld the prohibition. The reasoning was that for the Mexican fruit to enter the U.S. research must be designed, data collected, and interpretations of the results made. During these negotiations the Mexican producers adopted the quality standards required by APHIS with respect to the plague risk evaluation and administration that obliged them to establish measures of control for orchards and packers, as well as for transport systems (Chart 5).

Chart 5	
Proceso de resolución de la prohibición del aguacate mexicano a la exportación	
1990 - 1992	Mexico sends to the government of The United States three plans of work under which Michoacán's avocado might be exported to The United States. It begins the process of resolution with an agreement to ministerial level to consider the prohibition and with the sending, on the part of Mexico, of a plan of work to the APHIS. The first one was rejected due to the fact that a quality fruit was needed and free of pesticides, besides scientific tests to establish that areas proposed in the plan were free of plagues cuarentenarias. APHIS accepts the evidences of the Mexican government of the free areas of plagues, but it is in disagreement on the protocols to determine if the avocados were inn-keepers of the fly of the fruit
1993 - 1994	November 15, 1994, an agreement was achieved on scientific protocols and the APHIS authorized the entry of Mexican avocado in Alaska
1995	APHIS published a proposal to allow the entry of avocado Hass of orchards free of plagues towards certain states of the United States with fytosanitary additional requirements as to restrict the import to the period from November to February
1996 - 1997	The periods of negotiation are re-opened and the prohibition gets up partially in February, 1997. The APHIS publishes the final rule that allows the import of avocado Hass of Michoacán under such restrictions as the fact that the avocado that is imported from Mexico should be produced only in four Michoacán's municipalities: Uruapan, Peribán, Tancítaro and Salvador Escalante, that they were found free of plagues
1999	Were exported to the United States 9,789 ton of avocado. The follow-up of the procedure of production and of quality they were constituted in the base of decision for the marketing of the avocado in the American territory
2001 - 2007	Gradual opening of the American market, which initiated in 1992 and spread gradually in the year 1997, 2001, 2005, up to covering the totality of the territory in 2007. The Mexican avocados were accepted until 2007 in 47 states of the United States (they were exceptions Florida, California and Hawaii)
Source: Personal elaboration based on USDA (1997).	

Thus in 1993, after completing the field research in which fruit flies were not found in the orchards in Michoacan (Aluja, 2003), APHIS overturned its decision and allowed the import of four varieties of avocados to the States of Colorado, Kansas, Kentucky, Missouri, Utah, and Virginia.<sup>43</sup> Thereafter, in November 1994 APHIS announced that it had evaluated the Mexican governmental requirements with respect to the export of Hass avocados from certified orchards in Michoacan to 19 States in the U.S., and in 1997, in spite of the opposition of the avocado industry in the United States, the USDA published the final ruling that permitted the entrance of avocado only during the months from November through February, the winter season (Bredahl, 2000).<sup>44</sup> The 1990s thus began, and the avocado SIS of Michoacan saw economic and institutional movements to overcome the obstacle of the blocking of exports to the United States market. These changes included those in strict regulatory regime with the creation of sanitary and plant health systems.<sup>45</sup> With this regulatory framework that began in 1990 with negotiations between APHIS, SAGARPA and the JLSVs<sup>46</sup>, the avocado industry in Mexico adopted the standards established by APHIS. On the local level the JLSVs were created to be the governmental intermediaries between the producers and the government of the United States in the supervision of the compliance with APHIS regulations.

In order to deal with non-tariff barriers related to the export of avocados to the United States, producers and packers developed two types of organizations. The first is based on the regional plant health campaign from 1990 to 1997 and the expansion of small private campaigns in the industry which are made up of members of the same family (Stanford, 1999). This type of organization arose from the avocado producers of Michoacan's response to the plant health prohibition of the entrance of avocados into California (Paz Vega, 1983, cited in Stanford, 1999). The second type of organization was formed in order to avoid the strictness of formal organizations for avocado producers, such as local agriculture associations created decades before. These made it difficult to solve problems related to productions, such the Federal Agriculture Association of 1932, that did not allow participation in commercialization or financing for cultivation. Thus in 1990 the majority of the cooperatives, credit unions and associations established during the 1970s and 1980s were no

---

<sup>43</sup> In the Federal Register the USDA Publisher a risk analysis for Mexican avocados, and the Proposed Rule that permitted the ingress of the product throughout the U.S. for the 12 months of the year. One of the sustaining principles for the opening of the territories was the publication of the research realized by Aluja (2003), "Non-host Status of Commercial *Persea Americana* Hass to *Anastrepha ludens*, *Anastrepha oblique*, *Anastrepha serpentine*, and *Anastrepha striata*" in the Journal of Economic Entomology, 2003 in Mexico wherein he presented scientific arguments that upheld the conclusion that the Hass avocado does not host the fruit fly.

<sup>44</sup> In 1997 6,000 tons of avocados were sold to 19 States in the U.S., and from the 2005-2006 harvest 16,000 tons were sold to 49 States ([sagarpa.gob.mx/eges/sembrando/2007/3-2007.pdf](http://sagarpa.gob.mx/eges/sembrando/2007/3-2007.pdf), viewed May 3, 2008).

<sup>45</sup> Today, avocado commerce and plant health are subject to eight norms: NOM 066 FITO-2002, which indicates specification for avocado plant health and transport; NOM 128 SCFI-1998, which contains commercial information for the labeling of agricultural products; NMX-FF-016-2002 SCFI, which contains the specification for non-industrialized food products for human consumption; NMX-006-1982, which contains the glossary for the previous norm; 120-SSA 1-1994, which specifies the practices for hygiene and health for the processing of foods and alcoholic and non-alcoholic drinks; the Stan Code 197/0995 Norm Codex for avocados, EUREPGAP, norm of the European Union; NOM-EM-034-FITO-2000.

<sup>46</sup> The first tasks of the JLSVs began in 1990 with the Vegetal Health and the Faculty of Agro-biology of UMSNH, actions that strengthened from 1993 with the creation of the State Committee of Vegetal Health. During 1994 and 1995 Federal and State funding through agreements with the State Committee, and from 1996 aid was approved through the program of the Farmers' Alliance, which was described this year in the publication of Official Mexican Norm NOM-066-FITO-1995. Plant health activities were strengthened for avocados with the application of the Plant Health Format. The JLSVs, operating on a municipal level, have implemented and administrated all of the sanitary and plant health campaigns for certifying orchards and for declaring them free from plague. APHIS inspectors supervise the operations of local sanitary and plant health campaigns, offering confidence for the abilities of Mexican producers to comply with the standards.

longer operational. With the disappearance of these organisms, private businesses, frequently made up of those who had been members of the associations, were able to acquire equipment and packing plants, and in this way anonymous societies were generated (Stanford, 1999).

The positive effects that arose from the prohibition include, principally, the transference of technology and innovation. The first has been brought about with the diffusion of production techniques for cultivation through the JLSVs and the activities of foreign packing businesses, Calavo, Mission de Mexico and West Pack, amongst others, who have introduced new post-harvest techniques and better packing equipment to producers whose orchards have been certified. The dynamics of these changes have stimulated innovation in the avocado SIS in Michoacan, a theme that will be treated in the following Section.

### **3.2.2 New relationships in research**

From the 1980s the sources of technological innovation were defined over the period from 1914 to 1980. In fact, as we have seen above, the organizations that generated innovations – producers, the Cupanda Cooperative, CICTAMEX, the Faculty of Agro-biology and INIFAP – and the diffusers of innovations – AALPAUM, the Association of Producers of Periban, CONAFRUT and FERTIMEX – have established research networks for seed varieties and watering and harvesting techniques for avocados, but in this second stage the networks were strengthened between the principal agents of SIS, research institutes and universities such as CICTAMEX, INIFAP and the Faculty of Agro-biology, respectively. There also arose governmental organizations such as the PRODUCE Foundation and the JLSVs<sup>47</sup> and producers' and packers' associations, along with the creation of Associations such as the Unified Services of Agricultural Matters (SUMA), which are dedicated to the services of cutting, harvest and transport of avocados. As an example, the Sánchez Colín Foundation has realized research with avocados and other fruits whose results have been published in scientific articles, papers, booklets and fliers, offering technical assistance and training courses<sup>48</sup>. Since its foundation CICTAMEX has made various scientific and technological contributions for the cultivation of avocados such as i) genetic innovation, principally with the development for varieties of avocado and the establishment of a germ-plasma bank for Persea and fine species; ii) development of new cultivation techniques<sup>49</sup>; iii) establishment of collaborative agreements with national and international institutes that has allowed for exchanges that have optimized research resources<sup>50</sup>; and iv) participation in certified Fairs and Societies<sup>51</sup> and international projects<sup>52</sup>.

---

<sup>47</sup> The principal factor in the beginning of certification of orchards for export and the improvement of cultivation and harvest was the regulation by the United States, and because of this, the JLSVs are powerful agents in the achievement of compliance to the norms (PRODUCE Foundation, 2006).

<sup>48</sup> CICTAMEX has four research departments – ecology, plant health, parasites, and training and divulgation.

<sup>49</sup> Development of intermediate grafting techniques using small size varieties to reduce the size of the trees for commercial trees, for selection criteria to determine the size of the trees, to determine the stomatal density and proportion of transversal area of the bark, techniques for poli-grafting and manual pollenization as instruments to advance genetic improvement, the creation of new techniques such as ringing to increase tree production. Evaluation of the orchard-nursery technique in genetic improvement programs to reduce time and space requirements, development and evaluation of the technique of induction of mutations through irradiation, application of vegetative grafting propagation techniques, determination of species in trips to avocado orchards, identification of pollenizing insects and pollenization studies.

<sup>50</sup> Principally through agreements with research centers such as the Hans Merensky Foundation, the Experimental Center La Mayora, the Universidad Catolica de Valparaiso, the National Plant Health Consulting Committee, the Universidad Autonoma Chapingo, the Universidad Veracruzana, the Postgraduate School, the Universidad Autonoma de Queretaro, the Cupanda Cooperative, the Institute of Agriculture, Hydroponics, Forestry and Fishing Training of the State of Mexico, Seed Inspection and Certification Service, and the Canary Institute of Agricultural Research.

<sup>51</sup> The Mexican Society of Horticulture Sciences, the Mexican Society of Genetic Cytology, the Mexican Society of Entomology, the Mexican Academy of Engineering.

In this second stage AAALPAUM and the Faculty of Agro-biology, with the aid of the PRODUCE Foundation of Michoacan A.C. and the FIRA Agency of Uruapan<sup>53</sup> undertook activities in the transference of technology for avocado producers in the region of Uruapan and thereby allowing for assistance and exchange of experience between producers, technicians and students<sup>54</sup>.

The INIFAP Experimental Center in Uruapan was founded in 1977 and began with research activities in the forestry sector, and from 1985 was integrated by the Institutes of Agricultural, Fishing and Forestry Research of the Secretariat of Agriculture and Hydraulic Resources (SARH), which strengthened the research staff for the agricultural sector<sup>55</sup> and began to plan research into avocado cultivation. INIFAP provides services to the different Experimental Centers, and the disciplines they deal with are: i) research project development, validation and transference of technology of high socio-economic impact to improve productivity, quality and health within a criteria of sustainability; ii) plant-animal health diagnosis and laboratory analysis; iii) technological packets for different regions, products and production systems; iv) evaluation of plant and animal varieties; v) training, validation and transference of technology; vi) production and distribution of high quality vegetable and fish genetic material; vii) production and sale of improved seeds; and viii) evaluation, development and distribution of veterinarians and biologists, along with the effectiveness of agro-chemicals.

INIFAP, along with the Center for Forestry and Ecological Postgraduate Studies (CEFAP) of Venezuela, has realized at least four avocado research projects: technology for fertilization, integrated management of illnesses through the use of climatic and phenological prediction models; illness control through monitoring during critical phenological avocado stages; and the post-harvest management of the fruit. As can be seen in Chart 6, these four projects have generated innovations in the formulas for fertilizers, in the integrated management of the most common avocado plagues of anthracnosis, stringiness and tree stress, techniques for fertilizer application, management of orchard nutrition and harvest. The results of this research are principally reflected in the reduction of production costs, improvement of avocado quality, and for all of this, an increase in income for the producers in foreign sales<sup>56</sup>.

---

<sup>52</sup> International projects with institutions such as the German-Israeli Agreement for agricultural research (GIARA), whose objective is the exploration, collection and evaluation of Latin American avocado types. In this project researchers from ARO Volcani Center of Israel, the University of Hohenheim Stuttgart, Germany, and CICTAMEX participate in collaboration with the Postgraduate School, the Universidad Autonoma Chipingo, the International Plant Health Resources Committee (IBPGR), INIFAP, the Inter-American Institute of Agricultural Sciences (IICA) and INECOL:

<sup>53</sup> According to the numbers given by the FIRA Agency of Uruapan, during the period from 1998-2006 this agency authorized 997.5 million pesos in credit for agriculture (70%) and equipment parts.

<sup>54</sup> Some of these activities were undertaken in 2003 and 2003 consisted of technological information exchange with regard to the relation of fertilization and pruning in courses, workshops and conferences about the cultivation of the avocado in Michoacan, and the use, management and application of products for plant nutrition, for post-harvest management of agricultural and fishing products, field demonstrations of weed control, efficient machine use, pollenization with bees, and good harvesting techniques.

<sup>55</sup> The scientific personnel is made up of 24 researchers, of which 58% are dedicated to forestry research and the rest work in disciplines such as entomology, plant pathology, biotechnology, genetic resources, agro-climatology, fenology, nutrition and catering. They also count on a laboratory for plant pathology, another for bio-technology, and an avocado experimental area of 3.75 hectares. Currently they are developing a bank of native American avocado germ-plasma that to date includes 600 collections of 24 studies of the Hass variety (*persea americana mill*).

<sup>56</sup> Interview with Dr. Ignacio Vidales, INIFAP, Experimental Center in Uruapan.



Chart 6

**Technology transfer INIFAP – producers by problematic questions, innovation and results**

Problematic questions	Innovation	Results
<p>Rise supported of the costs of production (20 % per year)</p> <p>Nutrition of the trees that originates problems in the process of production (excess in the application of nitrogen in 54 % of the cultivated surface and deficiencies of other elements like phosphorus, calcium, magnesium, zinc and boron that they influence in a negative way in the performance of the trees and in the quality of the avocado)</p> <p>Ignorance of great part of the producers of the technology on fertilization, water application of irrigation, control of plagues and diseases of the fruit, plant, and of the root</p>	<p>Generation of new formulations of fertilizers, application of manures and new methods of application of fertilizers in production trees</p>	<p>Savings of 16 % in the costs of the inputs for the fertilization without deterioration of the soil and phreatic surface in 20 thousand hectares</p>
<p>Endemic diseases (anthracnose and scab of the avocado) that affect the tie of the flower and fruit in 10 %; they affect the photosynthetic capacity of the tree and the production and quality of the fruit in 30 %</p>	<p>Integrated managing of the anthracnose, scab and sadness of the avocado in pre-harvest process</p>	<p>Increasing of production of 0.25 ton of exports x \$6000.00 ton = \$1500.00/ha</p> <p>Improving the quality of the avocado exports 1.2 ton x \$6,000.00/ton = \$7,200.00/ha.</p> <p>Savings of agrochemical products \$2,000.00/ha</p> <p>Profits: \$12,450.00 - \$3,800.00 = \$8,650.00/ha</p>
<p>The trips causes that 25 % of the fruit loses quality in its external appearance, which generates that the commercial value of the avocado is very much minor to the current price on the market</p>	<p>Development of technologies and calendars of application of fertilizers for the control of the trips on having taken as a base the monitoring of populations of the plague and his relation with the different conditions of the tress</p>	<p>Improving the quality of the avocado for exportation and, therefore, additional revenues</p> <p>Reduction of the application of insecticides synthetic and savings for the frequent application of agrochemical.</p> <p>Transfer of technological package that generated additional utilities</p>
<p>Not favorable position for the Mexican avocado on international markets due to the deficiency in avocado quality was originates for: 1) sending of avocado insufficiently mature; 2) physiological disorders that demonstrate in the flesh of the avocado as spots, disagreeable at sight and that can be caused by cold or by factors pre-harvest such as the nutritional deficiencies in the orchards or by the deficient managing pos-harvest.</p> <p>As a whole these factors provoke economic losses of 10 % on the volumes exported annually and prices lower than that of the avocados sent by other countries to the principal markets of exportation</p>	<p>Managing of the orchards during the phase of production in the aspects of nutrition and health to avoid deterioration of the quality of the avocado</p> <p>Managing of the fruit during the crop to preserve the quality</p>	<p>Increasing of 50 % of the revenue for the sale of avocado of exportation</p>

Source: Personal elaboration based on INIFAP.

The PRODUCE Foundation, along with AALPAUM, the Faculty of Agro-biology, and FIRA, have undertaken technological transference and validation projects in applied research for avocado producers in the Uruapan region, with the purpose of diffusing available technology through training and diffusion schemes appropriate to the socio-economic and environmental conditions in the area (Chart 7). The principal learning activities have been through technological exchange tours for producers and technical advisors about nutrition, fertilization and watering and pruning, courses for integrated control of plagues and tree illnesses, post-harvest, and aspects of orchard health, field demonstration for producers and technical advisors for weed control, machinery management and equipment calibration, pollination and good practices for harvest, and there have been conferences for producers and technical advisors on themes such as pollination, fenology and nutrition. These leaning activities, as can be seen in Chart 7, have promoted useful publications for producers, training for human resources, and development of storage centers and logistics for market penetration.

Chart 7		
Fundación PRODUCE – AALPAUM – UMSNH: proyectos de transferencia de tecnología a los productores de aguacate		
Problematic questions	Innovation	Results
Need of technical information for the integrated managing of the avocado Hass cultivation Hass in Michoacán's State	Transfer of the knowledge generated in phenology and nutrition of the avocado Hass in Michoacán's	Twenty technical personnel qualified in the integrated managing of avocado cultivation Publication of the technical Guide on the integrated managing of avocado cultivation
Need of seed adapted for the different producing zones and selections elite of avocado Hass	Identification and validation of genotypes of avocado with adjustment to the different zones of production and with desirable characteristics as <i>portainjertos</i> , as well as identification of selections of avocado Hass elite in Michoacán's state	Selection of genetic material of avocado Hass Elite with desirable characteristics as <i>portainjertos</i>
COMA, AALPAUM, IMTA, Colegio de Posgraduados (COLPOS)	Diagnose of the current condition o the hydrological basin that supplies to the production avocado zone of Michoacán's, and recommendations for the best use of the water, its conservation and retention	Diagnose and documented recommendations of the present and future of the hydrological basin Menu of technological offers to improve the use of the forest resource and water
Need to articulate the phenology, the development of plagues and diseases with the climatic environment of the avocado region	Transfer of technology of intelligent systems for capture of decisions using the climatic information, phenology and population dynamics of plagues and diseases in the avocado	Transfer of the program “system of intelligence of markets”, applied by 50 producers
To favor the administrative and technical capacities of the small producers of Avocado of Michoacán's	Administrative and technical innovation for small producers of avocado of Michoacán's state	Development of administrative agenda under plans of business individuals and its implementation in producers with less than 5 has of sowing
To diminish the use of agrochemical, implementing BPA and of innocuousness that the markets stir the opening into action	Evaluation of organisms for the control of plagues and cultivation diseases of the avocado in Michoacán	To catalogue of the organisms that offset the plagues and diseases (technological development for its reproduction in local laboratories)
Shortage of supply of avocado on market of the southwest and north of Mexico	Strategy of repositioning and reclassification of the supply to the domestic market	Development of centers of collection and logistics of penetration to these markets
Source: Personal elaboration based on Foundation PRODUCE Michoacán, A.C.		

Over all, the propensity for innovation of the avocado system in Michoacan began at the end of the 1950s and beginning of the 1960s with the cultivation on the commercial level. The introduction

of improved seeds of the Hass variety by individual producers and cooperatives was the first innovation in avocado cultivation in the region<sup>57</sup>.

Since this period in the sub-system of producers knowledge has been generated about the cultivation of avocado, producing strong growth. Incremental innovations realized by higher educational institutions, both local (INIFAP and the Faculty of Agro-biology) and regional (CICTAMEX), have combined the technical opportunities with the specific necessities for cultivation and for production, harvest and commercialization. The technological improvements have been in the development of new varieties based on improved genetics of the fruit as well as adaptations of the cultivating systems in other countries, technology for the integrated management of orchards, and mechanization of harvest processes, all of which have resulted in the established demands of norms for export.

There have been three agents in technical change in the cultivation of avocados. Firstly, the businesses that count on great extensions of land, watering systems and capital, whose production is oriented towards the external market; producers in transition (community farms and small land owners) who have productive capacity, a determined infrastructure for watering and whose production is directed principally towards the internal market. Their organization is absent or inefficient, making it difficult to obtain credit, technology, commercial possibilities or administrative training. There are also marginally producing farms with no infrastructure who produce only for the local market or self-consumption.

The second group of agents is the federal government, through the Secretariat of Agriculture, and the third is made up of three research institutes (INIFAP, CICTAMEX and the Postgraduate School) and two public universities (the Faculty of Agro-biology of UMSNH and the Universidad Autonoma de Chapingo).

Chart 8 shows the principal innovations developed by producers, principally orchard owners, research centers and governmental institutions, who deal with technology, production and aid. The first of these deal with genetic improvement and its incorporation into orchards, the prevention and control of plagues, agro-ecological and soil salinity, filtration of fertilizers into lower layers, and adaptation of new cultivation techniques and harvest mechanization, amongst others. With respect to the technical aid functions, from the 1970s the Secretariat of Agriculture has collaborated with producers in areas such as advisement, validation of export quality and help with negotiations for the commercialization of avocado in the United States market. The research institutes have collaborated in both functions, investment-production and aid and with advisement and training courses. The innovation activities undertaken by the agents of the producer sub-system has allowed for the development of learning mechanisms not only for producers but also for packers.

---

<sup>57</sup> Since 1950 improved seeds of varieties of avocado such as native American, Beicon, Fuerte, Rincón, Baco, Azteca, Atrixto, Zutano (from California), Colin V-33 and Rincoalt (national origin) have been introduced.

Chart 8		
Avocado cultivation: Technological change by innovator agent and innovation		
Innovators agents \ Innovations	Innovations by technological function	
	Investment – Production	Support
Diffusers of innovations Farmers	<ul style="list-style-type: none"> <li>• Incorporation of new varieties of avocado from 1960</li> <li>• Adoption of new avocado cultivation techniques</li> <li>• Nutrition of avocado tress</li> <li>• Improvement of avocado quality</li> <li>• New harvest practices with machinery or motorized conveyances</li> </ul>	<ul style="list-style-type: none"> <li>• Improvement of the cultural practices for the consumption of the avocado</li> <li>• Orientation of the production towards the market</li> </ul>
Diffusers of innovations Secretary of the Agriculture and Livestock Sector	<ul style="list-style-type: none"> <li>• Studies on ecological aspects for the selection of areas and the establishment of orchards</li> </ul>	<ul style="list-style-type: none"> <li>• Advising to primary producers</li> <li>• Validation of the quality of avocado of exportation</li> <li>• Advising on the negotiations for the marketing of the avocado on the American market on the frame of the NAFTA</li> </ul>
Generators of innovations CICTAMEX, INIFAP, Faculty of Agrobiology (UMSNH)	<ul style="list-style-type: none"> <li>• Genetic improvement of avocado varieties</li> <li>• Prevention and control of plagues</li> <li>• Distances of plantation, pruning of trees, mutation of varieties to achieve smaller trees.</li> <li>• Demonstrations in orchards on irrigation, control of plagues and diseases and chemical fertilization (Producers)</li> <li>• Organic handling of orchards.</li> <li>• Ecological issues to establish a orchard</li> <li>• Technologies for the establishment of nursery</li> <li>• Studies on filtration of chemical fertilizers to phreatic surface and utilization of organic products.</li> <li>• Study of salinity of the soil.</li> <li>• Studies of biotechnology</li> </ul>	<ul style="list-style-type: none"> <li>• New cultural and consumption practices</li> <li>• Direct advising to producers in field</li> <li>• Courses of training for the integrated maintenance of the cultivate</li> </ul>
Source: Personal elaboration based on interview data and Aguilar (2000).		

#### 4. Principal results

We consider that the avocado industry in Michoacan can be examined as a sectoral system of innovation. From this point of view we have discovered the innovative relationships between the elements of the system, which on one hand are the generating agents for innovation – INIFAP, the Faculty of Agro-biology of UMSNH, avocado producers and packers – and agents who diffuse the innovations – associations such as APEAM, AALPAUM, UDECAM, COMA, the PRODUCE Foundation of Michoacan, SEDAGRO, and avocado producers.

Mexico is an important consumer of avocados, and, particularly in Michoacan, there have been many avocado producers and exporters since the 1970s. We therefore ask what there is behind their outstanding commercial success. Answering this question requires more than a description, for one because there have been so many changes in the sector, and for another, it is difficult to attempt an analysis of each variable through a worldwide view. However, the many modifications in and between the elements of the system that have allowed for its success.

There are certain notes or distinct characteristics, at least four, as we will see below, that are present throughout the history of the sector and that also have been the base for national and international commercial advantages. To realize an analysis that includes all of the elements that

intervene in the avocado SIS, agents, knowledge base and institutions, we have divided the study into two periods, 1914 to 1980 and from that year to date, as we consider that it is easier to distinguish the characteristics of each element in each period.

The first particularity in the sector in both periods is the diffusion and application of the knowledge base generated on a worldwide level in disciplines such as chemistry, bio-technology, mechanical and electronic engineering, and information technologies. The advances in chemistry from the first of the past century brought chemical products – such as pesticides or insecticides, fungicides, herbicides, plant hormones, and fertilizers, and important nutrients in fruit development. From genetic engineering and bio-technology new seeds and been developed or characteristics have been improved with higher contents of protein, starch and oil. Good agro-biological products such as bio-insecticides or bio-fertilizers and the microbial, based on the use of microscopic fungus implanted in the roots, have helped to stabilize nutrients such as nitrogen and phosphorus, have aided in the development and growth of the plants. Progresses in mechanical and electronic engineering have introduced mechanical innovations into agriculture which today include electro-mechanics. Some of these are the agricultural tractor, seeders, harvesters and row-makers, amongst others, which are used in the treatment and rotation of the soil to oxygenate it and to aid in watering and planting of trees and other crops. With respect to information technology, the systems created have permitted many agricultural producers to use various sources of information from the internet or radio to obtain data for prices or climactic conditions to the diffusion of new technology through publication of specialized bulletins and training courses.

The diffusion of the knowledge base has occurred through two principal forms, which bring us to consider the second particularity of the avocado SIS: the creation of net words between the agricultural units and private organizations, and the role of free agents and agricultural extensions of the government through organizations that create innovations, such as INIFAP and the Faculty of Agro-biology. The extensions have been a predominate form through which the use of agricultural knowledge has been brought to methods, procedures and practices for avocado planting, harvesting and packing.

In the first period, the innovations for seeds and the techniques for planting trees were introduced with the resources of producers organized collectively in cooperatives and/or associations and by the private research institution of CICTAMEX with informal agreements. There were no contracts, an attribute that has come to distinguish research activities and diffusion of the technological innovations of the public research institutions, INIFAP and the Faculty of Agro-biology. From this initial network came the participation of organisms such as CONAFRUT, research institutions of the federal government, INIA and INIFAP and university factors such as the Faculty of Agro-biology in Uruapan, which have taken the knowledge about methods and agricultural techniques to the producers through informal education.

In the second period, although the sources of innovation have been the same, the network of relationships of the SIS have been redefined, first with the appearance of new promotional agents, the PRODUCE Foundation, CONAPA, COMA and the JLSVs, associations such as APEAM, SUMA, and assessment services. There have been financial institutions who have participated, BANCOMEXT and FIRA, and the public research activities and promotion for the sector have been led primarily by public universities (the Faculty of Agro-biology) and INIFAP, whose new tendencies are based in molecular and genomic research.

The connection between these agents includes the third element of SIS, the institutions. Tariff and non-tariff barriers for the entrance of avocados into the market, principally in the United States, have been determining factors for the initiation of activities of innovation and technological learning amongst the agents. This was notably brought about by negotiations between avocado producers and the Mexican government with the U.S. authorities in which the Department of Vegetal Heal of the

United States required compliance with non-threatening norms for the fruit and for certification of orchards free from plagues in Michoacan. With the passing of time the prohibition has been amended, although it has not disappeared completely for the imposition of sanitary and plant health norms and regulations in the production of avocados, all of which is also tied to the process of globalization.

If opening the market involves political modification, imposing commercial obstacles as in the case of the producers from Michoacan to bring about changes in their strategies with respect to their investments, production, networking and innovation and organizational technology. This is because in large part the evolution of the sub-system of producers has been dependent upon the flexibility for adaptation to the new agricultural market conditions in general and particularly to those of the United States and with technology and organizational innovation. The emergence of norms for quality assurance is highlighted as a consequence of competence and behavior of the global market that now demands specific criteria for commercial exchange of fresh agricultural products. This means that to be competitive in the international arena, agricultural units in their gestation and production process must assure product quality, which has permitted them to learn and accumulate technological abilities, as demonstrated in the market quota for producers in the United States, Canada and Japan.

It is precisely the compliance to norms that the fourth element of the system speaks: technological training and learning. The dialogue and connection between the regulations, learning and the formation of technological abilities are now clear. Quality standards are combined with the diverse types of knowledge of the producers, and their application allows for technological learning at the time the members of the agricultural unit systemize and codify the best productive practices. Technological learning has generated changes in productive and organizational routines, and with this basic and intermediate innovative training. Thus the majority of the cultivators have learned while storing, administrating and transporting a combination of experiences, abilities and knowledge provided by research institutes, universities, associations and foundations. Quality norms are an institution, and with them the uncertainty of the market has been reduced.

The commercial emphasis of the SIS has generated economic benefits for the sale of avocados. It has become clear that none of the primary elements of the SIS is autonomous; each one is related with all of the others, and each one determines and is determined by the others. It is necessary that they agree, in greater or lesser level, with the other elements – the knowledge base, technological learning and the institutions.

## Bibliography

- Aguilar, C., (2000), "Sistema nacional de innovación. Una aproximación teórica para la agricultura. El caso del cultivo de aguacate en Michoacán", [eumed.net/cursecon/ecolat/mx/cac-inno-a.htm](http://eumed.net/cursecon/ecolat/mx/cac-inno-a.htm).
- Aguirre, S. y A. E. Bárcenas, (1999), *Las tesis de agrobiología sobre aguacate*, UMSNH, México.
- Aluja, M., (2003), "Nonhost Status of Commercial Persea americana Hass to Anastrepha ludens, Anastrepha obliqua, Anastrepha serpentina, and Anastrepha striata", *Journal of Economic Entomology*, vol. 96, no. 3, pp. 1693 – 1703.
- American Farm Bureau, (1991), "NAFTA: Effects on Agriculture" in *Fruits and Vegetable Issues 4*.
- Aragón, E., M. Campos y A. Fouquet, (2007), *The emergence of new succesful export activities in Mexico*, Escuela de Graduado en Administración Pública y Política Pública, EGAP, ITESM, México.
- Bárcenas, O. y S. Aguirre, (2005), *Pasado, presente y futuro del aguacate en Michoacán*, UMSNH, Facultad de Agrobiología, "Presidente Juárez", México.
- Bell, M. y K. Pavitt, (1995), "The development of technological capabilities", en *Trade, technology, and international competitiveness*, Economic Development Institute of the World Bank, Estados Unidos.
- Bonales, J. y M. Sánchez, (2003), *Competitividad Internacional de las Empresas Exportadoras de Aguacate*, UMSNH, ININEE, México.

- Bredahl, M., (2000), "Trade liberalization Under NAFTA: trade in avocados, NAFTA", Report Card on Agriculture; Proceedings of the 6th Agricultural and Food Policy Systems Information Workshop - 2000, <http://ageconsearch.umn.edu/handle/123456789/19177>
- Breschi, S. y F. Malerba, (1997), "Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics, and Spatial Boundaries" en Edquist C. y M. McKelvey, (2000) (editores), *Systems of innovation: growth, competitiveness and employment*, Elgar Reference Collection, Londres.
- Lall, S., (1992), "Technological Capabilities and Industrialization", *World Development*, Vol. 20, No. 2, pp. 165-86.
- López, et al., (1998), *Situación actual de los recursos genéticos del género Persea y especies afines preservados en el Estado de México*, Memoria Fundación Salvador Sánchez Colín CICTAMEX S.C. Coatepec Harinas.
- Malerba, F., (2004), "Sectoral systems of innovation: basic concepts", en Malerba, F., (editor), *Sectoral Systems of Innovation. Concepts, Issues and Analyses of Six Major Sectors in Europe*, Cambridge University Press, Cambridge.
- Orden, D., (2002), "Mexico-U.S. Avocado Trade Expansion", Keeping the Border Open, The Eight Agricultural and Food Policy Information Workshop, Puerto Vallarta, México, 7-9 de marzo ([farmfoundation.org/flags.htm](http://farmfoundation.org/flags.htm) fecha de consulta 12 mayo 2007).
- Roberts, D., T. Josling y D. Orden, (1999), A framework for analyzing technical trade barriers in agricultural markets, Market and Trade Economics Division, Economic Research Service, U.Department of Agriculture, Technical Bulletin no. 1876, <http://ageconsearch.umn.edu/handle/123456789/1523>.
- Roberts, D., y D. Orden, (1996), "Determinants of Technical Barriers to Trade: The Case of U.S. Phytosanitary Restrictions on Mexican Avocados, 1972-1995", en D. Orden y D. Roberts (editores), *Understanding Technical Barriers to Agricultural Trade*, University of Minnesota, pp. 117-60.
- Salazar, S., L. Zamora-Cuevas y R. Vega-López, (2005), "Actualización sobre la Industria del Aguacate en Michoacán, México", en California Avocado Society, yearbook 87, pp. 45-54.
- Sánchez, G., (2006), *El cluster del aguacate en Michoacán*, Fundación PRODUCE Michoacán, México.
- Sánchez, P., (2003), *Producción orgánica de aguacate. Manejo sustentable del suelo*, Fundación PRODUCE Michoacán, SEDAGRO, SAGARPA, México.
- Sánchez, S. et al., (2003), *Historia del Aguacate en México*, Fundación Sánchez Colín, Estado de México.
- Sánchez, S., (1999), "Nuevas tecnologías en el cultivo del aguacate", *Academia Mexicana de Ingeniería*.
- Solleiro, J. y R. Castañón, (1999), "Technological strategies of successful Latin American biotechnological firms, *Electronic Journal of Biotechnology*, no. 2, pp. 26-35, [scielo-test.conicyt.cl](http://scielo-test.conicyt.cl)
- Solleiro, J. y R. Castañón, (2005), "Competitividad y sistemas de innovación: los retos para la inserción de México en el contexto global", *OEI Temas de Iberoamérica*, Globalización, Ciencia y Tecnología, pp. 165-196.
- Stanford, L., (1999), "Ante la globalización del tratado de libre comercio: el caso de los meloneros de Michoacán", en Lara, S. y M. Chauvet (coordinadores), *La inserción de la Agricultura Mexicana en la economía mundial*, INAH, UAM, UNAM, Plaza y Valdés, Vol. 1, México.
- Stanford, L., (1998), *Mexico's Empresario in Export Agriculture: Examining the Avocado Industry of Michoacán*, Department of Sociology and Anthropology, New Mexico State University

Electronic pages

<http://www.agrifrut.com.mx>  
<http://www.agronet.com.mx>  
<http://www.apeamac.com>  
<http://www.aproam.com>,  
<http://www.avocado.org>  
<http://www.avocadosource.com>  
<http://www.avoking.com>  
<http://www.calavo.com>  
<http://www.chapingo.mx>  
<http://www.comtrade.un.org/>  
<http://www.cupanda.com.mx>  
<http://www.delcampo.com.mx/>  
<http://www.faostat.fao.org/>  
<http://www.producemich.org.mx>  
<http://www.searchportal.information.com>  
<http://www.sedagro.michoacan.gob.mx/seidrus/index.php>  
<http://www.siap.gob.mx/>